HEATING & VENTILATING

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

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Interpreting the Use of District Steam in Heating Buildings

By JOHN F. COLLINS, JR.†

IN Pittsburgh, the Allegheny County Steam Heating Company serves district steam to the "Golden Triangle," the principal business district. The Steam Utilization Section of this company has, over the past three years, evolved a plan by which it can be estimated how much steam for space heating buildings of various sizes, uses, ages and conditions will be required per normal year. It is felt that the idea, which centers about the use of steam in pounds per cubic foot per normal year, has sufficient merit that others might be interested in adopting it. Table B gives some useful figures of steam use on this basis, but in using them for other locations, care must be taken to apply the proper factors as explained later in the article.

Although a number of equally interesting facts were learned about the use of steam for water heating and other minor applications, which it is hoped may form the basis of a future paper, this present article will be concerned principally with the major use of steam, for space heating. In this connection, however, some figures for estimating water heating steam are given.

What follows is an outline of the progress made and difficulties encountered in putting the plan into effect and a statement of how the data produced may be used elsewhere.

Objective

In the spring of 1933 it became evident to the sales officials of the company that it was desirable to improve upon the former methods of checking up on the use of steam by its customers to prevent waste and to create greater satisfaction with the service. Incidentally, the sales engineers wished to provide a means for the quick determination of the amount of steam that a properly operated building, of any class, taking district steam, actually rather than theoretically, should use. This information is not only useful in work for existing customers but is valuable in making estimates of the steam requirements of prospective purchasers.

Initial Plan

The first plan decided upon consisted of plotting on charts every customer's steam consumption for each use; that is, for space heating, water heating, cooking, laundering, pressing, etc. At the end of each investigation period, which was approximately one-third month or about ten days in length, any customer using an abnormally large amount of steam was to be called upon promptly by the sales contact man assigned to his building and informed of the condition. As bills are rendered each month, with such quick notice, the customer would still have an opportunity to correct the trouble and prevent his receiving a large steam bill.

The original space heating charts were made in what is probably the usual form, as shown in Fig. 1, with the horizontal or abscissa base representing "time" and the vertical or ordinate base "steam use" in pounds per degree-day[1]. The charts were made with 36 vertical columns, one for each of the three periods in each of the 12 months. The columns were arranged to begin with August and end with July so that with the summer months at the ends of the chart, a single entire heating season, considered as being 10 months in length, might be presented unbroken on a single chart. The six extra columns for the months of July and August were useful only on the charts for such minor applications of steam as used in the summer time. Vertically the charts had 50 spaces on which, as stated, pounds per degree-day in whatever range was necessary for the particular building studies were shown.

To put this plan into effect, it was unnecessary to add to the expense of meter reading, as to assure proper measurement they were already being read four times per month. In fact, this cost was actually decreased as one monthly reading, which was a duplication made for checking purposes, was eliminated and thereafter only the three "periodic" readings were taken.

Difficulties Encountered

A number of troubles presented themselves which made it possible to report at first only on a few customers. Later most of the others were added, a few at a time each period.

Probably the most serious difficulty encountered was lack of meters. In a considerable number of buildings using steam for several purposes a single steam or condensate meter, or a group of condensate meters, arranged in parallel, correctly measured the entire consumption for billing purposes, but there was no way of discriminating between the uses. Obviously, the total steam for all uses could not be divided by degree-days and proper answers obtained, for minor uses are not proportional to degree-days. In many cases it was necessary to estimate steam for the minor uses, the principal one of which is water heating, from known data and subtract this use from the total consumption, leaving only space heating steam.

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[1]As defined in the HEATING & VENTILATING DEGREE-DAY HANDBOOK, "the degree-day is the product of one (day) times the number of degrees the average mean temperature outside is below 65 F." The 65 F temperature is an empirically determined base assumed to be the temperature above which steam is not required.

Water Heating Estimates

In previous years the total of the annual steam consumed for water heating in buildings where only one meter measured both the space heating steam use and the water heating use (which was to be subtracted) had been arrived at by multiplying the measured steam use in July and August by 6. This metered use was for water heating, since only rarely is steam used in these warm months for space heating. This multiplier 6 probably was selected on the assumption that in the 12 months of the year the total steam used would be six times that of the two summer months.

On the basis that the final temperature to which the water is to be heated remains the same throughout the year, which usually is true, the multiplier 6 is only proper where the water entering the water heater is also always at a constant temperature and where the hot water use is in equal amount in all 12 months or where there are compensating factors equivalent to this condition.

In Pittsburgh, well water which is heated in a number of buildings, does remain more or less constant at 60 F throughout the year but the city water supply which is used in most of the buildings, in July, reaches a temperature of approximately 80 F and in February often drops as low as 35 F. Disregarding for the moment other factors such as variation in use which, however, must be thought of in estimating, and considering only change in city water temperature in Pittsburgh, it can be shown that instead of 6. the multiplier for water heated to 180 F is 7 and heated only to 100 F is as high as 12. This applies to buildings without economizers. Where these are in use and are of ample size, the proper multiplier depends on how hot the water is to be heated and may be as low as 4.

Once the proper yearly multiplier and steam use have been computed, it is possible to estimate the monthly and periodic uses. Water heating often requires about 10% as much steam as the yearly amount of steam for space heating in the same building. A 10% error in estimating the steam for water heating will result only in a 1% error in the steam use in pounds per degree-day for space heating. These data are given here to show that from the physical laws governing the heating of water, from figures as to variation in hot water use and from statistics of steam used for water heating secured in buildings having separate meters measuring this use, it is practical to estimate the steam used for water heating in other locations where such meters are not present, but care must be taken to consider all conditions.

Likewise, where the facts are known, the steam required for other minor uses can be estimated and subtracted from the total to leave space heating steam. In some complicated cases, too difficult to estimate, it was found desirable to install additional meters. The preparation of charts for these customers had to be deferred temporarily when the system was being gotten under way. In a few places where meters were not installed, because of the work involved, a different sort of, and less satisfactory, chart has since been developed.

Adjustment of Degree-Days

In the beginning a refinement was made in the computation of degree-days. It was thought where buildings such as banks are closed on Sundays and holidays and heated only to 55 F or 60 F, the degree-days used on the chart computations should be modified by decreasing the number to compensate for this. This lead to the use of the term "adjusted degree-days," which meant for example, that in a period containing 240 standard degree-days, 230 degree-days might have been selected as the proper figure if one Sunday had occurred in the 10-day period or perhaps 222 if there had been two Sundays or one and a holiday. The subtraction was intended to make the pounds per degree-day show up on the chart more nearly as a straight horizontal line throughout the heating season, something which a considerable number of heating en-

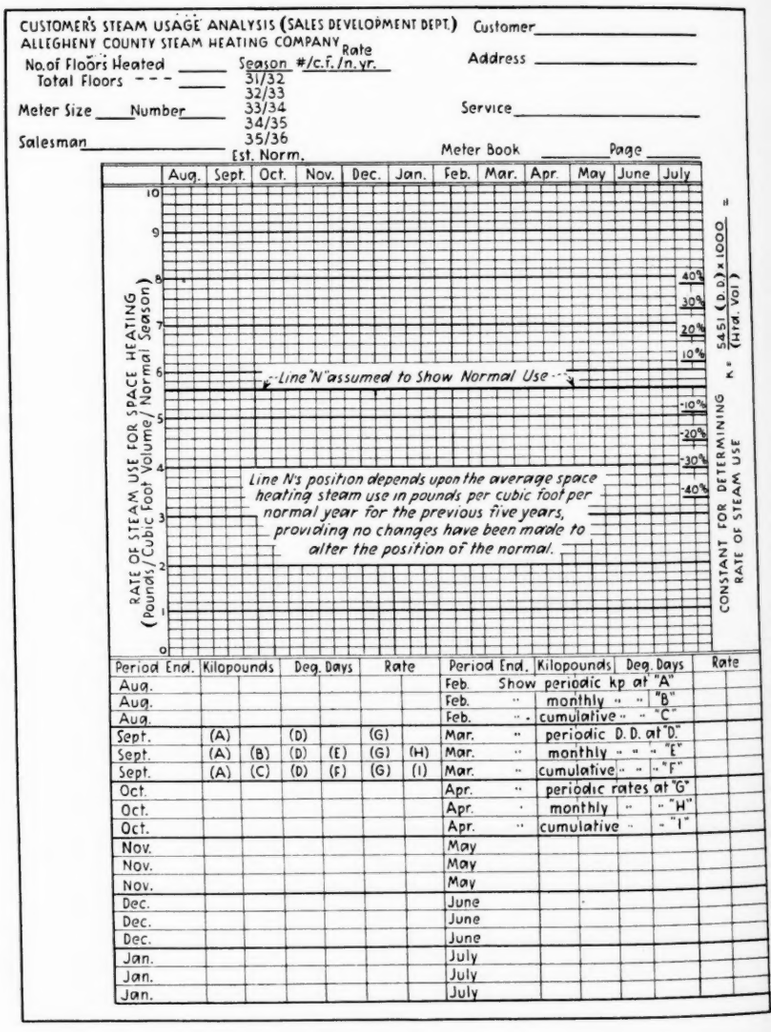


Fig. 1.

gineers who have studied the matter agree is not the case. This idea was abandoned because it was found difficult to explain to the satisfaction of the customers. It was easier to make clear why the rate went up or down about 3% when it could be said that the basis was degree-days derived from the United States Weather Bureau daily mean temperatures, rather than some adjusted basis. Consideration was given also, in arriving at this decision, to other disregarded influences which tend to make the pounds per degree-day curve for the average building deviate from a straight line, such as: 1.—The allowable inaccuracy of meters; 2.—the change in other weather conditions than temperatures, such as wind velocity and direction, humidity and sunshine; 3.—the moving of the United States Weather Bureau's official thermometer and changing of the method of taking official temperatures; 4.—night temperature maintenance at daytime level in extremely cold weather, and 5.—changed requirements for human comfort in mild weather.

Another difficulty, which was not solved due to lack of time during the season of 1933-34, was to know definitely whether customers using steam at a rather uniform rate in pounds per degree-day, were using only what they required or were continuously wasting it. At the beginning of the latter half of the season, as a basis of comparison from period to period, a tentative normal was established for each building based upon the amount of steam used in the particular building in pounds per degree-day during the first half of the season. This, of course, did not solve the problem.

The New Plan

It was felt that it would be solved if the space heating steam use in some satisfactory unit was known for each particular building of any group of buildings, arranged according to use, such as department stores. Some set of units such as "per degree-day per cubic foot of net heated or gross space," or some other basis such as "per square foot of floor space," "per square foot of exposed area," or "per square foot of installed radiation," or even in percentage of calculated theoretical heat loss from the buildings, had to be selected.

It was agreed that the method picked must be accurate and at the same time easily understood. The problem was worked upon during the summer of 1934. It was decided that the volumetric basis was preferable to that of floor area because of the variation in ceiling heights. It was known that some buildings are much over-radiated while others do not have sufficient radiation surface, so this basis was eliminated. The heat loss basis was considered favorably but was passed by due to the large amount of calculation necessary and the difficulty that would occur in explaining it. Finally, it was decided that since what is being done is to heat a given space, the best basis is "per cubic foot of net heated space." This method gave figures so much below unity that it was thought best to change the basis to "per 1,000 cu. ft. of volume." This also seemed not to be as desirable a unit as per cubic foot and some time later it was discovered that if instead of pounds per degree-day per cubic foot, the basis were made pounds per normal year (in the case of Pittsburgh, 5,451 degree-days) per cubic foot, the results for all properly operated buildings would be numbers between 1.0 and 10, small, understandable, and easily remembered. Most people in the heating business now are familiar with the term "pounds per degree-day." To get steam use on the new basis, simply multiply pounds per degree-day by the degree-days in a normal year in your city and divide by the net heated volume of the building.

Example: A building with an inside width of 40 ft., an inside length of 100 ft. and an inside height of 100 ft. (sum of the floor surface to ceiling surface heights) or a volume of 400,000 cu. ft., in a city which normally has a heating season of 5,000 degree-days, used 100,000 lb. of steam in a 10-day heating "period" containing 200 degree-days.

The rate is 100,000/200 or 500 lb. per degree-day or 500 $\times$ 5,000/400,000 or 6.25 lb. per cu. ft. per normal year, but degree-days per normal year/ volume for any particular building is a constant K. K = 5,000/400,000 or 0.0125. Therefore, pounds per degree-day $\times$ K is pounds per cubic foot per normal year or, in the example, 500 $\times$ 0.0125 or 6.25 lb. per cu. ft. per normal year.

It is simply explained to the customer that if he uses steam throughout a normal season at a rate which he used it during the previous "period," or 6.25 lb. per cu. ft., he would use 400,000 $\times$ 6.25 lb. or 2,500,000 lb., which would cost him, say, $1,250. If it were known from experience that the building could be heated for 5.25 lb. per cu. ft. per normal year, he could save 400,000 lb., or say $200.

Execution of the Plan

The new plan involved no change in meter reading and the principal revision made to the charts, Fig. 1, was that "pounds per cubic foot per normal year" replaced "pounds per degree-day." For all properly operated buildings the bottom chart line was marked "0.0 lb. per cu. ft." and the top line "10.0 lb. per cu. ft." resulting in each of the 50 vertical spaces representing 0.2 lb. per cu. ft. per normal year. This was considered an advantage, as when the rate of steam use in one or more buildings increased an equal amount, 1 lb. for example, the same length of vertical line on each chart represented this rise. The charts for the few buildings using steam at a rate of more than 10 lb. per cu. ft. during some periods were arranged the same way with each space representing 0.2 lb. per cu. ft. but the range was raised from 2 to 12 lb. or 5 to 15 lb., etc., as required.

Grouping of Buildings

As mentioned previously, the buildings and stores of the customers had been divided into groups according to occupancy or use in order that the rate of steam use in similar buildings might be compared. This idea was not a new one, it having been used in a number of cities and commented upon at some length at several conventions of the National District Heating Associa-

tion. The original groups selected in Pittsburgh were found by use to require some modification. Those now in use are as follows:

Hotels, clubs and institutions
Public buildings
Theaters and theater buildings
Churches
Banks and bank office buildings
Very large office buildings
Large office buildings
Medium office buildings
Small office buildings
Department stores
Five and ten cent stores and buildings
Night schools and/or dance halls and buildings
Drug stores and buildings
Jewelry stores and buildings
Men's stores and buildings
Shoe stores and buildings
Women's stores and buildings
Furniture or piano stores and buildings
Office supply stores and buildings
Large supply stores and buildings
Small supply stores and buildings
Warehouses and manufacturing buildings
Chain restaurants and lunchrooms
Other restaurants and lunchrooms
Buildings with restaurants
Miscellaneous unclassified customers

Figuring Net Heated Volume

Some question arose as to how net heated volume should be computed. For many years this steam company has had a standard for making such measurements by which outside walls, roofs, and floors, and also dead air spaces above ceilings, cold shafts, chimneys, and unheated basements, penthouses and other unheated parts of buildings are excluded but by which partition walls and columns and unoccupied but partially heated spaces are included.

It was decided that while there may be other bases just as good or even better, possibly including floor volume, no change should be made in the method in use, pending some agreement between the owners, the architects, the utilities and other interested parties on a standard method.

In Table A are given a number of methods used in other cities by steam companies for computing volumes.

It is unfortunate but obvious that until an agreement is reached, comparisons of the steam use per cubic foot such as had been made in the past for buildings in several cities, are valueless.

Figuring Degree-Days

The other factor in comparing steam use for space heating in buildings in several cities is "normal degree-days." Offhand, it might be thought that with the definition so clearly stated there could be no differences as to this figure. However, the author has discovered that the normal degree-days in use have not universally been computed from daily mean temperatures over a long period which should be done according to the definition of the unit. Instead, monthly mean temperatures, by which erroneous and a lower number of degree-days per normal year—however more easily—are obtained, have apparently been used on occasion. At least four figures for normal degree-days in Pittsburgh can be found, three of which can be shown to be in error. It will also be necessary to establish the degree-days by a universal method before comparisons can be successfully made between buildings in different cities.

Data for Table B

Two heating seasons have passed since the method of procedure outlined above was adopted. Not only have the records been kept by this plan in the interim but it has been found desirable to go back three years farther and make computations of pounds per cubic foot per normal year for these years.

There were the following total number of degree-days in Pittsburgh, where the normal number is 5,451, in each year of the five years for which computations were recorded.

1931-32—4,583
1932-33—5,099
1933-34—5,722
1934-35—5,044
1935-36—5,600 (to May 1)

From this it will be seen that there have been warm, average, and cold years, so that data for all kinds of weather are available for comparison for buildings in the several groups. The summary indicating the range of steam use in the various groups of buildings is given in Table B.

Work Involved

Probably it should be emphasized that a very considerable amount of work is involved in starting and carrying on such a system. The steam company in Pittsburgh had at the start the net heated volumes of about 40% of the buildings served. It was necessary to measure the others as soon as time was available, meanwhile, volumes were assumed based on plat book dimensions given for the buildings. Buildings apparently using too much or too little steam were found to be doing well when volumes were corrected. Occasionally, a building shows a marked change in rate. Sometimes this is found to be the result of tenants moving out of upper floors and the cutting off of steam from these areas, making a volume adjustment necessary.

TABLE A[2]—ITEMS INCLUDED IN COMPUTING VOLUMES BY VARIOUS STEAM COMPANIES

Items	New York, N. Y.	Baltimore, Md.	Pittsburgh, Pa.	Detroit, Mich.	St. Louis, Mo.	Portland, Oreg.
Heated air space above ground....	Yes	Yes	Yes	Yes	Yes	Yes
Unheated air space above ground..	Yes	Yes	No	No	Yes	Yes
Heated air space in basement.....	Special	Yes	Yes	Yes	Special	50%
Volume of outside walls.....	Yes	Yes	No	No	No	Yes
Volume of inside partitions and columns	Yes	Yes	Yes	See (1)	Yes	Yes Yes
Volume of floors above first.....	Yes	Yes	No	No	No	Yes
Volume of first or grade level floor	Yes	No	No	No	No	Yes
Volume of roof.....	Yes	No	No	No	No	Yes
Volume of fixtures and equipment.	Yes	Yes	Yes	Yes	Yes	Yes

[2]Data from National District Steam Association 1932 Proceedings, pages 205-7. (1)—Compensated for by taking dimensions in even feet.

The system has been found to be very satisfactory for local use in obtaining actual rather than theoretical steam requirements. A modification of the future, when sufficient data shall be available, may be the replacing of the straight, horizontal normal degree-day line by a curved one, taking into account those minor factors now neglected. Another change probably will be the replacing of the 65 F base temperature by ones of lower degree for such buildings as warehouses and parking garages not requiring such a high indoor temperature.

The use of the system as it stands reveals clearly that there are certain chronic steam wasters who in warm weather keep it turned on when not needed and in cold weather keep doors and windows open, necessitating excess use to keep the space warm. Often these are small establishments where the managers are interested primarily in sales of food, drugs, or merchandise and are unfamiliar with their heating systems. Temperature control systems often cannot be recommended because the possible saving will not justify their cost. The remedy is to remind such managers frequently that they can save money by carefully operating their heating systems.

The managements of buildings of any class of 500,000 cu. ft. or more of net heated volume using steam at a rate equivalent to 6 lb. per cu. ft. or higher per normal year (at Pittsburgh) should seriously consider improvements to their heating systems such as the installation of temperature control equipment as the savings will justify a considerable expenditure.

Application of Table B to Other Locations

The normal degree-days occurring in the principal cities of the United States and Canada range from approximately 1,000 at Jacksonville, Fla., to about 11,000 at Winnipeg, Manitoba. To estimate from Table B the amount of steam required per normal year in any city for any building falling within the groups given: 1.—Pick out the proper class of building; 2.—note the rate of steam use in Pittsburgh for such a building; 3.—divide the rate by 5,451, the normal degree-days in Pittsburgh; 4.—multiply the quotient by the normal degree-days (based on daily mean temperatures) in the city in which the building is located; 5.—divide the resulting rate of steam use by the ratio between the volume as computed in the city in which the building is located and in Pittsburgh.

Gross volumes are often about 1.33% of net heated volume.

Example: Assume it is desired to know the steam required per normal year to heat an old moving picture theater building of the usual construction in Spokane, Wash., and that gross volume is used there as a basis.

In Pittsburgh, 3.2 lb. per cu. ft. per normal year is required.

Normal degree-days in Spokane—6,085.

3.2 × 6,085/5,451 is 3.6.

3.6/[3]1.33 is 2.7 lb. per cu. ft. per normal year.

It is hoped that this article will be useful to those who desire a quick method of estimating actual, normal steam consumption for space heating in buildings.

TABLE B

Building Group	Space-Heating Steam Use In Pounds per Cubic Foot of Net Heated Space per Normal Year of 5,451 Degree-Days		
	Minimum	Average	Maximum
Large modern hotels	5.0	5.6	6.2
Medium class hotels	3.0	3.5	4.2
Small hotels	3.2	3.6	4.1
Club hotels	3.3	4.5	6.0
Public (city, county, state, federal) office buildings	4.0	5.0	9.2
Prisons	12.2	14.4	17.0
Morgues	10.4	12.2	15.1
Large modern moving picture theaters	1.8	2.1	2.4
Medium class moving picture theaters	2.5	3.2	4.3
Small moving picture theaters	5.6	6.5	7.2
Theater-office buildings	3.0	4.2	5.1
Churches	2.1	3.8	5.3
Large modern bank-office buildings	2.5	3.4	5.3
Older bank-office buildings	3.3	Varies	9.4
Modern banking buildings	3.4	4.6	5.5
Modern tower buildings	3.3	4.2	4.5
Very large modern office buildings	3.6	4.3	6.5
Other very large office buildings	4.8	5.8	7.3
Modern large office buildings	3.5	5.4	7.4
Other large office buildings	4.2	6.0	8.6
Medium size office buildings	3.6	6.0	9.0
Small store-office buildings (well operated)	2.4	5.7	7.2
Small store-office buildings (poorly operated)	12.4	16.8	18.6
Large department stores	1.5	1.8	2.2
Small department stores	1.7	2.7	4.0
Five and ten cent store buildings	1.3	3.1	6.4
Night schools and/or dance halls and buildings	4.1	5.9	8.2
Drugstores and drugstore buildings	5.0	8.0	13.0
Jewelry store buildings	2.0	5.2	9.6
Men's stores and buildings	2.2	4.5	9.0
Shoe stores and buildings	1.5	5.0	9.1
Women's stores and buildings	3.0	6.0	13.0
Furniture or piano stores and buildings	1.9	4.5	8.1
Office supply stores and buildings	2.1	5.0	6.1
Large supply stores and buildings	1.9	4.7	10.5
Small supply stores and buildings	1.8	6.0	11.4
Warehouses and manufacturing buildings	1.0	4.0	8.4
Restaurants	1.4	3.2	4.5
Lunchrooms	1.6	6.0	9.0
Buildings with restaurants	3.1	6.5	10.9
Parking garages	1.3	1.3	1.4
Bowling alleys and billiard parlors	1.6	5.6	10.3

[3]Assumed ratio between net heated and gross volumes.

Industrial Ventilation and Silicosis Prevention

The silicosis problem receiving concentrated study—exhaust ventilation, one of the methods of prevention

SILICOSIS is much to the fore in public interest. Being a disease caused by breathing air containing silica (or quartz), and for which there is no known cure, one of the methods of reducing its prevalence is to make use of ventilation air in factories where there is a hazard. Hence, it becomes a subject of interest and concern to those of us who deal with factory ventilation.

A number of events have served to bring silicosis into its present prominence. Not only is the disease now incurable but it is hard to diagnose and is slow in developing in many cases. It is not covered by accident liability or by occupational disease laws in many states and a worker or former employe could sustain a damage suit in some localities by claiming that he contracted the disease while at work and that this condition was due to negligence on the part of his employer. This situation resulted in the filing of many damage suits. So also did it cause legislatures of states to give consideration to silicosis as a menace calling for regulation. Attention of Congress was drawn to it following a tunnelling operation in West Virginia. As a result, the disease and the situation surrounding it have made the headlines.

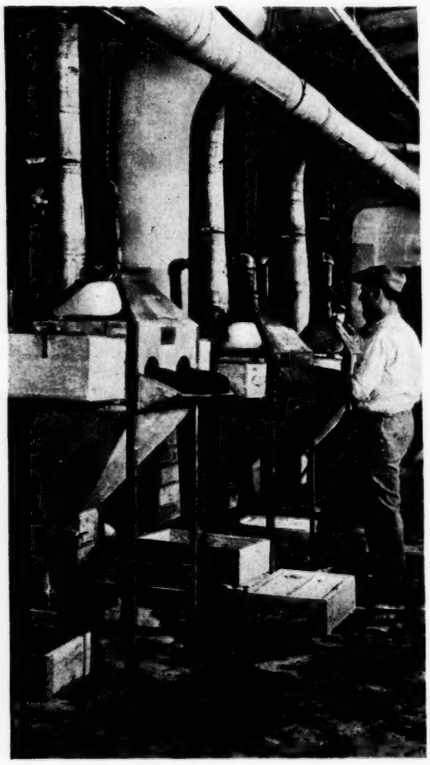
So much activity naturally has drawn attention in the past of those most directly affected, viz., factory owners and labor. Public factory inspection bureaus, insurance companies, and industrial health and hygiene workers also are affected and have moved to study what can be done both at once and in the future.

State legislatures in Illinois and in New York, two of the largest industrial states, have taken action as a result of the agitation and the litigation. Similar movements are now in progress elsewhere.

American Standards Association has a special committee working on the subject with the object of recommending standard procedures once the limits of concentration and similar basic information are found and systematized. Many of the trade associations as well as individual manufacturers in the dusty industries have done or are doing some work on silicosis as it affects them. So also The Air Hygiene Foundation is engaged in collecting available information on silicosis as well as on other air diseases.

On May 2 and 3 last a general conference was held at Washington under the auspices of the Department of Labor. This brought together 138 people drawn from the ranks of labor unions, employer associations, insurance officials, and public health physicians. The conference heard speakers present the problem of silicosis prevention as seen by labor, employer, and scientific workers. In addition to the material presented at the conference, action was taken to keep the subject open by the appointment of four committees to deal with specific aspects of the problem and to report later in the year at a further conference to be called by the Secretary of Labor. One committee is to handle prevention through medical control, one through engineering control, one will cover economic, legal, and insurance phases, while the fourth considers regulatory and administrative phases.

Personnel of the engineering control committee is as follows: chairman, Warren A. Cook, State Department of Health, Hartford, Conn.; Cyril Ainsworth, American Standards Association, New York; James R. Allen, International Harvester Co., Chicago; J. J. Bloomfield, U. S. Public Health Service, Washington, D. C.; Thomas G. Donnelly, State Federation of Labor, Columbus, Ohio; Prof. Philip Drinker, Harvard School of Public Health, Boston, Mass.; C. H. Fry, chief, Bureau of Industrial Accident Prevention, Department of Industrial Relations, San Francisco, Calif.; Leonard Greenberg, M. D., Division of Industrial Hygiene, New York State Department of Labor, New York; Daniel Harrington, U. S. Bureau of Mines, Washington, D. C.; Willis G. Hazard, Owens-Illinois Glass Co., Toledo, Ohio; E. O. Jones, American Foundrymen's Association, Chicago; E. G. Melter, Employees' Mutual Liability Co., Milwaukee, Wis.; W. P. Yant, supervising engineer, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa. This committee met at Hartford on May 13 to organize and map its program.



N. Y. State Dep't of Labor, Div. of Industrial Hygiene

Sand blast hoods with exhaust system for protection of workers against silicosis.

With the problem of silicosis control and prevention thus being attacked in concerted fashion it is to be expected that results of a tangible nature will follow.

Interest in silicosis in also serving to prompt and promote a rebirth of interest in the whole subject of industrial air. There are other dust problems in industry besides those due to silica, such as the problems arising from fumes and industrial poisons and those due to high temperatures and humidities. How far the present interest in silicosis will result in these problems being attacked in determined fashion is not now predictable but these subjects are also due for an eventual examination both to learn how much of a health problem they really are, and to determine the basic engineering information necessary to install engineering control methods where necessary.

Committees working a plan to devise engineering control, including exhaust ventilation, report that the only practical method of approach is to study each particular industry and its problems separately as there is no generalized or blanket solution.

Also before a logical procedure can be followed in solving dust problems it is necessary to know the greatest allowable concentration of dust particles in the air. Knowing this, if the relation between the amount of ventilation air used and this dust concentration can be established, the key to a solution using ventilation air is at hand. The safe concentrations for silica dust are still to be established, as are those for a great many of the troublesome and dangerous dusts fumes, and poisons. Neither are the quantities of ventilation air necessary to produce and maintain these concentrations known for many processes and many industries. From this it is easy to understand why there is still much to be done before prevention by use of exhaust ventilation can be put on a logical basis.

Office quarters of the W. Bingham Co., Cleveland, showing the acoustic-ventilating ceiling, which has 900,000 outlets supplying conditioned air to the room.

900,000 Air Inlets

By M. A. BOYD†

WHEN H. D. Cram, of the W. Bingham Co., Cleveland, accepted recommendations for the reconditioning of the office quarters of the largest wholesale hardware establishment in the country under one roof, he was approving the initiation of a new construction the results from which have more than justified the pioneering risk.

This new construction involved the delivery of 30,000 c.f.m. of washed, filtered, heated or cooled air to a single office space of 17,000 sq. ft. area, through 900,000 small ceiling air inlets, the inflow of air at such velocities as to eliminate any chance of objectionable drafts yet so distributed that the room temperature variation over the entire area was found to be less than one degree.

The offices of the W. Bingham Company house over 200 employes and occupy one entire end of the third floor of its large "flat-slab" reinforced concrete warehouse building. The space has 41 bays of approximately 20-ft. squares, a total volume of about 200,000 cu. ft. and three outside exposures. Walker and Weeks, the architects of the original building, were commissioned to recondition the office quarters with a view of improving its ventilation, acoustics, and lighting up to latest standards.

Just prior to this, Mr. Tashjian, of the architectural firm, installed in an office, under test conditions, a new experimental ceiling with the view of accomplishing the following results:

Elimination of objectionable air drafts, air currents and eddies in ventilated or air conditioned spaces; provide uniform air distribution at low velocities; eliminate air noise; provide more efficient light reflecting zones over ceiling fixtures; provide ample sound absorption or acoustic treatment.

The experimental ceiling under test proved to be successful for the results desired and its application for the large installation was consequently authorized.

The Bingham installation in general is as follows: The entire space was to be heated or cooled from a central plant located on the fourth floor with no local radiators. The air washer, filter and heaters and main fourth floor supply ducts were installed and so laid out as to permit the addition of the cooling equipment

†Manager, Cleveland Office, Clark, MacMullen & Riley, Inc., Consulting Engineer.

later on with no change in the system.

The space is heated and ventilated by hot blast; divided into seven zones, each zone duct originating at a double plenum chamber, the mixing dampers for each zone being controlled by separate room thermostats located on columns.

Air is delivered to the space exclusively through the perforated ceiling from a ceiling plenum chamber, which, in turn, is supplied from 16 vertical ducts from the fourth floor supply ducts, terminating just under the fourth floor concrete slab.

Exhaust air openings are arranged in the conventional manner along the outside walls and exhaust is also provided in the center of the space at a stairway.

The required quantity of air input, heat loss, or heat gain, was calculated for each bay separately. New ceiling light fixture locations were determined in advance from temporary test fixtures.

Approximately six inches below the existing third floor ceiling the new ceiling was installed on furring, creating a shallow plenum chamber over the entire area divided into zones with airtight vertical diaphragms.

The ceiling proper consists of 1 in. special 24 in. x 24 in. fiber board tiles, with tongue and groove and bevelled joints, nailed to the furring, forming a single dead level ceiling.

A certain number of the ceiling tiles are perforated in advance for 3/8-in. diameter holes at a 45° angle at 1 in. on centers in both directions, extending completely through the tile. Each perforated tile therefore has 529 3/8-in. holes.

From the data obtained from the test ceiling the number of perforated tiles required for the necessary air input for each separate bay was determined and laid out in pleasing patterns of varying forms, filling in with solid unperforated tiles over light fixture zone areas, and under main supply duct outlets.

The entire undersurface of the completed ceiling was painted with three coats of lead and oil paint of a very light cream tint.

The entire space is lighted from one to four indirect lighting units per bay, hung approximately 36 in. below ceiling level, and with 500-watt lamps, a uniform light intensity of 18- to 21-ft. candles was obtained at work table level.

The characteristic results observed from the completed installation are an extremely pleasing, dead level ceiling with no ducts or apparent conventional air inlet grilles; uniform air input over entire area at about 40 to 50 f.p.m. velocity; ample solid area over light fixture zones for extremely good light reflection without glare; ample sound absorbing results, from relatively fewer open holes in ratio to ceiling area, from 45° inclined holes, than obtainable otherwise; a ceiling surface that can be repainted as often as desired without reducing its air input capacity or sound absorbing quality; no objectionable draft, air currents, or eddies, when delivering air at maximum rate, viz., 30,000 c.f.m. of air; absolutely quiet operation, no air flow noise noticeable anywhere.

With a total of 900,000 air inlets it is fairly safe to claim that this 17,000 sq. ft. acoustic and ventilating ceiling is the largest single air inlet grille in use.

Pushing Ahead in Arctic Weather

INGENUITY must be the dominant trait in the successful contractor's character. Examples are constantly coming to light. One of the most interesting examples recently revealed shows how 500 workmen, sheltered within a huge tarpaulin "Eskimo suit," 950 ft. around the waist, toiled through a record-breaking Canadian winter at New Toronto, Ontario, to complete a three-story reinforced concrete can factory in time to handle the crops and brews of 1936.

Under an acre of adjustable roof that served as the hood of this snug, electric lighted, steam heated arctic outfit which has grown up with the building, operations were carried on in three shifts a day while mercury around zero paralyzed construction throughout Canada and almost half of the United States. Starting in the dead of winter, January 14 to be exact, with 6,500 cu. yd. of concrete to be poured, the contractor agreed to have the plant ready for occupancy on April 15 of this year.

With a battery of unit heaters in lieu of a fur lining and a network of electric lights screwed on the floating roof, the men were able to work without risk of health or workmanship. Albert S. Low, vice-president and chief engineer of the Austin Co. organization, designed this enclosure.

The storm jacket surrounded the entire plant at a distance of several feet outside the interior walls. Its tarpaulins were stretched upon a stout stud wall, which grew upward with the roof as the building progressed. The roof, sloped to facilitate clearing the snows, was waterproofed as well. It moved upward in sections with construction, always standing about eight feet above the floor about to be poured, and remaining there until after the concrete had had time to set thoroughly.

The roof stood upon a forest of 400 jacks, which rose upward through temporary wedge shaped openings in the center of each 20-ft. bay, entirely independent of concrete forms and columns. Thus the enclosure grew with the building much as a cocoon grows with the silkworm spinning away inside.

Concrete delivered hot by transit-mix from a material yard a quarter-mile away was poured and vibrated at temperatures which seldom varied more than 10°, from 60° to 70°, when the weather outside ranged between zero and the freezing mark.—*"Barron's," National Financial Weekly*

There Is Still Time to Enter

HEATING & VENTILATING'S

DEGREE-DAY COMPETITION

●

But this competition, open to everyone under the rules at the bottom of this page, closes on June 30. You can be one of those to get a cash award, and you don't have to be a famous author to win.

The idea is to send us a short, concise story of how you have made use of this unit in your own work. Tell your experiences with it. Describe what you have done. Maybe you have introduced modifications and variations of your own—if so, that's all right—just include them too. Any interesting or constructive ideas, it makes no difference what, just so they have to do with the Degree-Day and its use.

It is now over ten years since the Degree-Day unit appeared. HEATING & VENTILATING is proud of its part in bringing this unit to the attention of the industry, and of the fact that it has published Degree-Day figures for your use for almost nine years. We feel a responsibility for helping our friends and readers make the best possible use of the Degree-Day.

We know from correspondence of the wide interest in this unit. We know that all the uses haven't been described. You'll be helping others by sending in your story. Also you'll be helping yourself because of the generous cash awards. Your story need take only a little of your time—the shortest has equal chance with the longest manuscript. Read the rules below and send in your story now. Be sure to get it in the mail before June 30.

FIRST PRIZE . . .	**$100**
Second Prize . . .	**30**
Third Prize	**15**
Fourth Prize . . .	**10**
Fifth Prize	**5**

RULES OF THE COMPETITION

1.—Write an original story for exclusive publication in HEATING & VENTILATING covering any one or all of the following subjects—(a) How you use Degree-Day data in your business; (b) Your experience with the Degree-Day; (c) Results of using the Degree-Day. This is interpreted to mean that a manuscript is eligible if on any phase of the Degree-Day or its use.

2.—If possible typewrite your manuscript neatly on one side of paper only. Include any forms used together with an explanation of them. If curves, charts, or tables are regularly used in connection with the Degree-Day, enclose a copy of them and refer to their use in your story. Such curves, charts, etc., need not be done in ink but must be legible.

3.—Enclose the original manuscript in the same envelope with a letter written on your own or your firm's business letterhead and signed by you.

4.—Judges of the competition will consist of Eugene D. Milener, Secretary, Industrial Gas Section, American Gas Association, who originated the Degree-Day method, and the editors of HEATING & VENTILATING. Decision of the judges is final. While literary merit will be considered, principal consideration will be given to originality, simplicity and general usefulness to others of the application described in the story. No manuscript of more than 3,000 words, or one estimated to require more than four pages in HEATING & VENTILATING, will be considered. No entries returned. Submit one entry only.

5.—Competition is open to any one actively engaged in heating, ventilating, piping, or air conditioning work in the United States and Canada. Entries will not be considered if coming from professional writers, correspondents, or employes of publishers.

6.—Manuscripts submitted are with the understanding that whether or not they receive a prize in this competition, they are for possible use in regular or special issues of HEATING & VENTILATING or other publications of The Industrial Press.

7.—Winners of the competition will be announced in the August, 1936, issue of HEATING & VENTILATING. Competition closes June 30, 1936, and all entries must be postmarked before midnight of that date.

8.—Mail entry to Degree-Day Competition, HEATING & VENTILATING, 148 Lafayette St., New York, N. Y.

Calculation of Steam Flow in Underground Distribution Loops

By S. M. ARNOW†

IN central heating installations, accurate determination of distribution system capacity is of the utmost importance, especially if the lines are located in congested central city districts where available space is limited and the installation of new lines is costly. In order to effect the most economical utilization, it is necessary to load the lines in such a manner that full utilization is made of the differential existing between the pressure carried at the station and that required by the most remote customer on the line. This applies to the main or trunk lines as well as to the auxiliary or cross headers, the differential in the latter case being the pressure existing in the main at the point of take-off and at the most remote customers connected to that line. From this, it may be seen that the accurate determination of the pressure at the principal take-off points in the main line is absolutely essential. Since steam flow calculations are laborious, a number of charts have been developed to facilitate solution of these problems. Most of the charts, however, do not take into account the varying density of the steam and it becomes necessary, when the pressure drop is considerable, to either make several trial calculations with assumed densities, or to figure the pressure drop in short sections of line, using a different density at every step. In this article a simplified formula which eliminates both of these objections is developed and the method of its application is illustrated.

Flow of Steam in Pipes

Most of the formulas for calculating pressure drop in pipes due to steam flow may be put into the following form:

$$Pd = \frac{FW^2L}{Dd^5} \qquad (1)$$

where

Pd = pressure drop in lb. per sq. in.,
F = coefficient,
W = flow in lb. per min.,
L = equivalent length of pipe in ft., i.e. actual length plus equivalent straight pipe length due to valves and fittings,
D = *mean* density in lb. per cu. ft., i.e. density corresponding to mean pressure in the line,
d = inside pipe diameter in in.

In the majority of problems in steam distribution work, W, L, and d are known and the pressure drop is the value required. Under these conditions the unknown factors are Pd and D. Since mean density depends on the pressure drop, it becomes necessary to assume a mean pressure and use the corresponding density to make a trial calculation. However, since the assumed and the calculated mean pressure are seldom identical, the calculation must be repeated several times until these agree. Moreover, since this procedure must be gone through for every change of conditions in flow, length, diameter, or density, it is apparent that a method of obviating this difficulty is highly desirable. By assuming that the steam flows through the pipe at a constant total heat, it is possible to eliminate the density factor in equation (1). The error thus introduced is small, especially in well insulated lines such as used in modern underground steam distribution, and may be neglected in view of the time saving involved. With this assumption, equation (1) may be changed algebraically to the following form:

$$P_2 = \sqrt{P_1^2 - KW^2L} \qquad (2)$$

where

P_1 and P_2 are initial and final pressure respectively, in lb. per sq. in. *absolute.*
W = flow in *lb. per hr.*
L = equivalent length in ft.
K = a constant, depending on pipe size and initial steam conditions.

This formula gives the final pressure direct and does not involve mean density, D.

It may be noted that the final pressure at any point in a line is also the initial pressure for the next point, i.e.,

$$P_1^2 - K_1W_1^2L_1 = P_2^2 \text{ and } P_2^2 - K_2W_2^2L_2 = P_3^2 \text{ etc.} \qquad (3)$$

Hence,

$$P_1^2 - K_1W_1^2L_1 - K_2W_2^2L_2 - K_3W_3^2L_3 \ldots \; K_nW_n^2L_n = P_n^2 \qquad (4)$$

Therefore

$$P_{\text{final}} = \sqrt{P_1^2 - \Sigma KW^2L} \qquad (5)$$

This means that if just the terminal pressure of the line is required, it is necessary only to add the products

TABLE 1.

Pipe Size		Values of K	
		Standard	Extra Heavy
	⅛	0.368,2	1.393
	¼	0.061,46	0.185,5
	⅜	0.010,28	0.025,32
	½	0.002,629	0.005,643
	¾	0.000,509,7	0.000,938,2
	1	0.000,125,8	0.000,213,9
	1¼	0.000,026,00	0.000,040,37
	1½	0.000,010,79	0.000,016,15
	2	0.000,002,620	0.000,003,758
	2½	0.000,000,966,1	0.000,001,359
	3	0.000,000,288,3	0.000,000,394,1
	3½	0.000,000,128,9	0.000,000,173,3
	4	0.000,000,064,58	0.000,000,085,37
	4½	0.000,000,034,92	0.000,000,045,64
	5	0.000,000,018,87	0.000,000,024,41
	6	0.000,000,007,003	0.000,000,009,231
	7	0.000,000,003,193	0.000,000,004,361
	8	0.000,000,001,616	0.000,000,002,060
	10	0.000,000,000,485,3	0.000,000,000,599.9
	12	0.000,000,000,188,4	0.000,000,000,210,3
	14	0.000,000,000,112,3	0.000,000,000,124,0
	16	0.000,000,000,054,04	0.000,000,000,058,88
O.D.	18	0.000,000,000,028,54	0.000,000,000,030,78
	20	0.000,000,000,016,19	0.000,000,000,017,32
	24	0.000,000,000,006,130	0.000,000,000,006,480

†Engineering Department, Philadelphia Electric Company.

of KW^2L of the various points and subtract the result from the square of the initial pressure to get the square of the final pressure.

In order to facilitate calculations, Table 1 of values of K to use with equation (2) has been worked out based on the B & W coefficients: $F = 0.0001310\ (1+\frac{3.6}{d})$ and steam having a pressure of 150 lb. gauge and 1,229 B.t.u. total heat ($P_1V_1 = 498$). For any other steam condition multiply value of K by $\frac{PV}{498}$

Example: It is required to pass 200,000 lb. of steam per hour through a 14-in. extra heavy pipe (13 in. inside diameter) 5,000 ft. long. Initial steam pressure 190 lb. per sq. in. abs., initial density (from steam tables) 0.382. $P_1V_1 = 498$. What is the final pressure?

Solution by equation (1):

$$W^2 = \left(\frac{200{,}000}{60}\right)^2 = 11{,}100{,}000$$

$$F = 0.000131\ (1+\frac{3.6}{d}) = 0.000131\ (1+\frac{3.6}{13}) = 0.0001672$$

$$P_2 = P_1 - \frac{FW^2L}{Dd^5}$$

$$P_2 = 190 - \frac{0.0001672 \times 11{,}100{,}000 \times 5000}{D \times 13^5} = 190 - \frac{25}{D}$$

1st Trial:
Assume $P_2 = 140$, average pressure is then 165, and $D = 0.331$

$$P_2 = 190 - \frac{25}{0.331} = 125.$$ **The assumed value for P_2 is obviously too high.**

2nd Trial:
Assume $P_2 = 110$, average pressure is 150, and $D = 0.301$

$$P_2 = 190 - \frac{25}{0.301} = 107.$$ **The assumed value for P_2 is still too high.**

3rd Trial:
Assume $P_2 = 106$, average pressure is 148, and $D = 0.298$

$$P_2 = 190 - \frac{25}{0.298} = 106,$$ **which agrees with the original assumption.**

Solution by equation (2):

$$P_2 = \sqrt{P_1^2 - KW^2L}$$

$$P_2 = \sqrt{190^2 - 1.24 \times 10^{-10} \times (200{,}000)^2 \times 5000} = \sqrt{36{,}100 - 24{,}800}$$

$$P_2 = 106.2$$

Thus it may be seen that three calculations were required by equation (1) whereas only one calculation suffices with equation (2).

While this method simplifies the calculation of pressure drops through single pipe lines, it is of particular benefit in the determination of flow through loops. A loop is a parallel circuit and the flow divides itself in such a manner that the pressure drop in both branches is equal. Where there are a number of take-offs along either branch of the loop, one can readily imagine the calculations involved if density correction were to be made at every point with its altered conditions. By using the formula given above it is possible to calculate

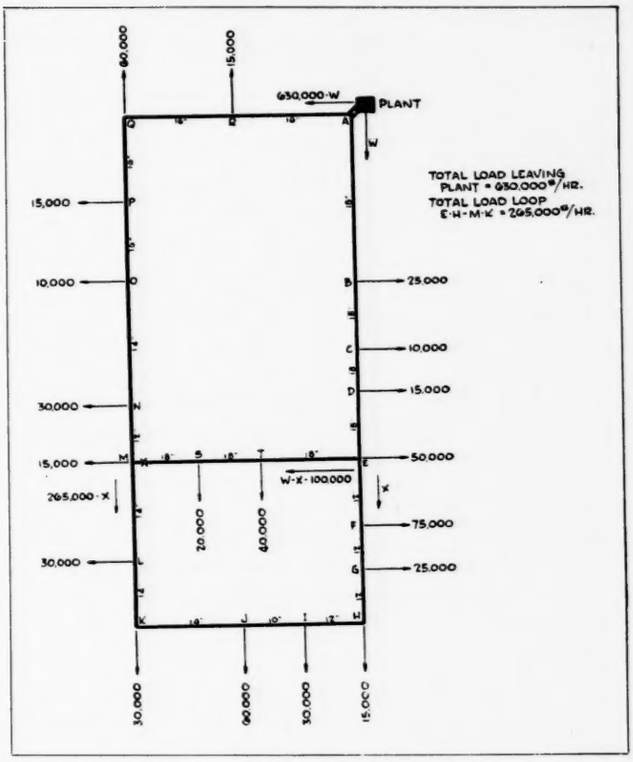


Fig. 1.

flow of steam in loops, eliminating most of the difficulties.

The following example illustrates the application of this method to loop calculations.

Single Loop

For the purpose of this article the system shown in Fig. 1 is assumed. The total amount of steam taken

TABLE 2.
(Going around loop in clockwise direction).

Section	Pipe Size	Equivalent Length ft.	Flow	KL flow²		
A-B	18	2,000	W-	$6.156 \times 10^{-8}W^2$		
B-C	18	800	W-25,000	$2.460 \times 10^{-8}W^2$	$-1.2 \times 10^{-3}W$ +	15
C-D	18	1,000	W-35,000	$3.078 \times 10^{-8}W^2$	$-2.2 \times 10^{-3}W$ +	38
D-E	18	500	W-50,000	$1.539 \times 10^{-8}W^2$	$-1.5 \times 10^{-3}W$ +	38
E-F	12	800	W-160,000	$16.830 \times 10^{-8}W^2$	$-53.9 \times 10^{-3}W$ +	4,310
F-G	12	500	W-235,000	$10.520 \times 10^{-8}W^2$	$-49.5 \times 10^{-3}W$ +	5,820
G-H	12	600	W-260,000	$12.620 \times 10^{-8}W^2$	$-65.6 \times 10^{-3}W$ +	8,550
H-I	12	400	W-275,000	$8.420 \times 10^{-8}W^2$	$-46.3 \times 10^{-3}W$ +	6,370
I-J	10	400	W-305,000	$24.000 \times 10^{-8}W^2$	$-146.2 \times 10^{-3}W$ +	22,350
	(6)		ΣKL flow² =	$85.623 \times 10^{-8}W^2$	$-366.4 \times 10^{-3}W$ +	47,491

TABLE 3.
(Going around loop in counterclockwise direction).

Section	Pipe Size	Equivalent Length ft.	Flow	KL flow²		
A-R	16	1,000	630,000-W	$5.888 \times 10^{-8}W^2$	$-74.1 \times 10^{-3}W$ +	23,380
R-Q	16	1,500	615,000-W	$8.83 \times 10^{-8}W^2$	$-108.5 \times 10^{-3}W$ +	33,400
Q-P	16	1,000	555,000-W	$5.888 \times 10^{-8}W^2$	$-65.4 \times 10^{-3}W$ +	18,100
P-O	16	800	480,000-W	$4.710 \times 10^{-8}W^2$	$-45.2 \times 10^{-3}W$ +	10,840
O-N	14	1,400	470,000-W	$17.380 \times 10^{-8}W^2$	$-163.1 \times 10^{-3}W$ +	38,400
N-M	12	600	440,000-W	$12.620 \times 10^{-8}W^2$	$-111.1 \times 10^{-3}W$ +	24,430
M-L	14	1,200	425,000-W	$14.890 \times 10^{-8}W^2$	$-126.4 \times 10^{-3}W$ +	26,850
L-K	14	700	395,000-W	$8.690 \times 10^{-8}W^2$	$-68.6 \times 10^{-3}W$ +	13,540
K-J	14	1,300	365,000-W	$16.110 \times 10^{-8}W^2$	$-117.8 \times 10^{-3}W$ +	21,480
(7)			ΣKL flow² =	$95.006 \times 10^{-8}W^2$	$-880.2 \times 10^{-3}W$ +	210,420

TABLE 4.

Section	Size	Equivalent Length	Flow	KW^2L	$(P_1^2-KW^2L)$	Final Pres. Lb. Per Sq. In. Gauge
A-B	18	2,000	338,000	7,040	20,060	127.1
B-C	18	800	313,000	2,410	17,650	118.2
C-D	18	1,000	303,000	2,824	14,826	107.2
D-E	18	500	288,000	1,278	13,548	101.6
E-F	12	800	178,000	5,330	8,218	86.0
F-G	12	500	103,000	1,118	7,100	69.6
G-H	12	600	78,000	769	6,331	64.9
H-I	12	400	63,000	334	5,997	62.8
I-J	10	400	33,000	261	5,736	61.0
A-R	16	1,000	292,000	5,020	22,080	133.9
R-Q	16	1,500	277,000	6,780	15,300	109.0
Q-P	16	1,000	217,000	2,765	12,535	97.3
P-O	16	800	142,000	950	11,585	93.0
O-N	14	1,400	132,000	3,020	8,565	77.9
N-M	12	600	102,000	1,310	7,255	70.5
M-L	14	1,200	87,000	1,125	6,130	63.6
L-K	14	700	57,000	282	5,848	61.8
K-J	14	1,300	27,000	117	5,731	61.0

off at the various branches indicated equals 630,000 lb. per hr. In order to make it a single loop, consider the valve at *M* closed, steam then flows from the plant at *A* through the two branches of the loop *A-H-J* and *A-Q-K-J*. The point of balance is taken at *J* although the results would be the same if a different balance point were assumed. Table 2 is a convenient form for use in the calculation.

Equating the summation of KL flow^2 on both sides of the loop and collecting terms we obtain

$$9.383 \times 10^{-8}W^2 - 0.5138W + 162{,}900 = 0 \qquad (8)$$

or

$$W = \frac{0.5138 \pm \sqrt{0.264 - 061}}{18.77 \times 10^{-8}} \qquad (9)$$

$$W = 338{,}000 \text{ lb.}$$

and

$$630{,}000 - W = 292{,}000 \text{ lb.}$$

We are now in a position to determine the pressures at various points in the loop since we know definitely the distribution of flow in both branches. This is given in Table 4. (It is assumed that the pressure at the station is 150 lb. per sq. in., gauge.)

It may be seen from Table 3 that the pressure at *J* is the same when going around either branch of the loop, i.e., the loop is balanced.

The same method may be followed in calculating a double loop, i.e., when the valve at *M* in Fig. 1 is open. It has also recently been used to compute a three-loop system having two sources of supply.

Synthetic Atmospheres Studied

A 12-year study of synthetic gases in relation to animal life shows that some artificial atmospheres can be created which challenge the superiority of the atmosphere of the world for maintaining life, according to Dr. J. Willard Hershey, McPherson College, Kansas, in a paper presented before the American Society of Chemical Engineers recently.

A wide range of synthetic atmospheres in the confinement of animals had been used, Doctor Hershey reported. Helium and oxygen apparently seem to be the best for animals to live in, in some cases apparently better than in normal atmospheres.

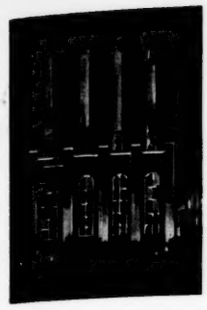
Pure gases are invariably fatal, Doctor Hershey stated. Animals die in pure oxygen in two to six days; in pure hydrogen, two to thirty-six minutes; in nitrogen, six minutes; in argon, three minutes; in neon, one minute and forty seconds; helium, two minutes and forty seconds; in nitrous oxide, ten minutes, and in carbon dioxide in fifty-five seconds.

By using 79% helium and 21% oxygen, Doctor Hershey reported, an atmosphere is formed under which animal life (white mice) will exist normally or, in some cases, apparently better than normal atmosphere. With helium the best percentage mixture seems to be 50% of each.

By using argon instead of helium, and with the same percentage mixtures, the report stated, the animals would not survive as they did with helium. By increasing the oxygen to 25% and decreasing the per cent of argon to 75%, life was supported normally so far as could be observed.

Synthetic atmosphere constitutes a very large field and little is known of it. In the field of practical application there is a wide range of values and uses. In deep sea diving, mines, and submarines, foul air is encountered and there is often a lack of sufficient pure air to sustain life. Aviators may carry a supply of prepared atmosphere with them when flying in the substratosphere.

Medical men may have a fair knowledge of the action of oxygen in the air, but little is understood by them concerning the other gases, especially the rare gases. The use of the oxygen tent in the treatment of pneumonia is a well-established medical practice today. The widest field probably will lie in the pathological applications, according to Doctor Hershey.



CENTRAL HEATING IN PWA HOUSING PROJECTS

MODERN HEAT DISTRIBUTION PRACTICE IN APARTMENT HOUSE GROUPS

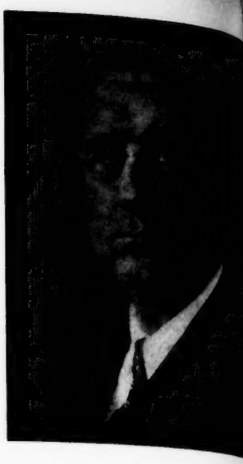
AS EXEMPLIFIED IN 12 TYPICAL PUBLIC WORKS PROJECTS,

WITH PLANS, SPECIFICATIONS, AND PHOTOGRAPHS

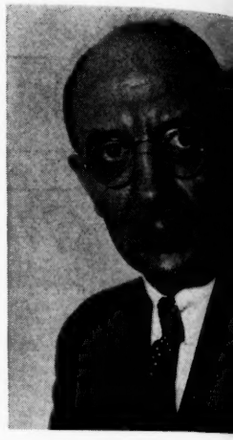
PWA PERSONNEL

HACKETT

HAROLD L. ICKES. Secretary of the Interior and Public Works Administrator. Born March 15, 1874, on a farm in Blair County, Pennsylvania. Worked his way through the University of Chicago by teaching in public night schools. Graduated in 1897 with an A.B. Degree, and later entered the Law School from which he graduated cum laude with the Degree of J.D. in 1907, and was admitted to the bar in that year. In 1932 he was chairman of the Western Progressive Headquarters. Following President Roosevelt's election he was appointed Secretary of the Interior on March 4, 1933. In July, 1933, he became Public Works Administrator.

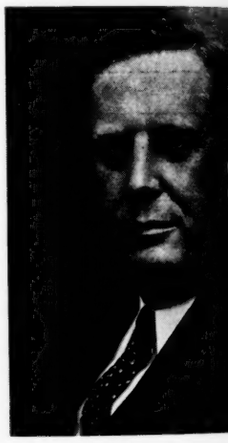


HORATIO B. HACKETT. Assistant Administrator of the Federal Housing Administration of Public Works. Born in Philadelphia May 8, 1880, he was graduated from the U. S. Military Academy in 1904 and was commissioned a second lieutenant of infantry. In 1906 he resigned to become associated with D. H. Burnham & Company, Chicago, as superintendent of building construction. He entered the war as Lieutenant Colonel, Third Field Artillery, Illinois National Guard, and was promoted to Colonel in January, 1918. Severely wounded in France and was awarded the Distinguished Service Medal and other decorations. Since 1922 he has been a partner in Holabird & Root, Chicago architects.

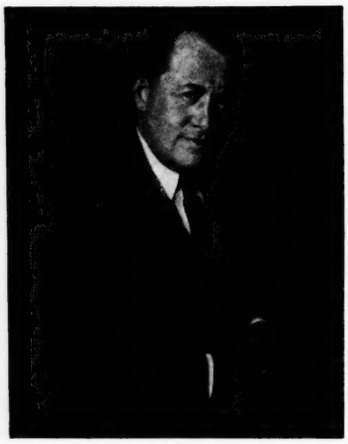


FITCH

A. R. CLAS. Director of PWA Housing Division. He is a son of a Milwaukee architect. Graduated from Harvard in 1909 where he specialized in architecture. Following study abroad he engaged in manufacturing. Was engaged in manufacture of truck and tractor motors and shells during the war. In 1924 he became associated with the architectural firm of D. H. Burnham & Company, Chicago architects, remaining with this organization until 1926. In 1927 he accepted a partnership in the firm of W. W. Ahlschlager, Chicago. Became partner in the architectural firm of Holabird & Root, Chicago, and remained with this firm until May 26, 1934, when he joined the Housing Division as Assistant Director.



CHARLES WALTON FITCH. Associate Director in charge of Branch II. Plans and Specifications; Branch IV, Construction; and Branch V, Management. Born in Washington, August 30, 1886. Attended Cornell University from which he received a Civil Engineering Degree in 1910. Engaged in railroad construction for seven years, principally with the Erie and Southern Railroads. For 11 years engaged in real estate development with Lyon & Fitch, Inc., with offices in Washington. Served with the 17th Railroad Engineers in France and returned as Lieutenant Colonel. For five years was Director of Exhibits and Associate General Manager of A Century of Progress. Permanent home, Chicago.



MAYETTE

JAMES WARREN CRAMER. Chief of Branch II, Plans and Specifications, in charge of design for all housing projects. Born September 28, 1886, in Washington. Came to the Housing Division from the George A. Fuller Company, general contractors, where he was construction manager for five years on large projects. For eight years after 1920, he was partner in Paschall & Cramer, Inc., and the Weller Construction Company, building and operating apartments in Washington and other cities. During the war he was a Major in the Construction Division of the Quartermaster Corps, serving at the Aviation Supply Depot at Middletown, Pa., a nitrate plant at Toledo, and at the completion of Langley Field, Virginia.

CHARLES E. MAYETTE. Principal Mechanical Engineer in charge of heating, plumbing, and other mechanical equipment. Born April 2, 1893, in Holyoke, Mass. Has for years been identified with the engineering of large building operations, specializing in central steam service, including installation of the present large system for the Government buildings in Washington. Has served with Stone & Webster, Inc., Dwight P. Robinson & Co., Inc., United Engineers & Constructors, Inc., and American District Steam Company, and was engineer in charge of the design and installation of the mechanical equipment of the Boston Madison Square Garden, and oil tank farms at Staten Island, and Coney Island shops. Served with 29th Engineers and Rainbow Division during the war. Member ASHVE & NDHA.

R. E. DOHERTY. Chief of Branch IV, Construction. Born in Minnesota February 4, 1888. Graduate in engineering from the University of Wisconsin 1910. Was Captain in the Corps of Engineers with the Pioneer Regiment during the war. Mr. Doherty came to the Housing Division from Thompson-Starrett Company, general contractors, where he was in charge of contracts, estimates, purchases, and general liaison work in their Chicago office. His home is Chicago.

AN INTRODUCTION TO HOUSING

It is estimated that the cost of housing projects now under construction by the Federal Administration of Public Works totals $130 million, of which we can estimate that roughly $13 million may be spent for heating. These projects are of tremendous sociological and economic significance and we find various groups in this country enthusiastically endorsing and others bitterly condemning the Government's housing program. It is inevitable, however, that regardless of individual opinions on the desirability of this program, projects involving such huge sums will have an important effect on building construction practice. Inasmuch as the projects now under construction are designed for an income group for which suitable housing has rarely before been provided, the methods used to meet the demand for adequate heating at low cost can reasonably be expected to have a long time effect on heating design and construction practice.

Consequently, we present here a portfolio of plans, specifications, and other condensed technical details relating to the heating of typical projects now under construction. Perhaps it is unnecessary to say that these eighteen pages cannot do justice to such a great undertaking as these projects represent, but the very brevity of this information may have some merit in that it will be more easily grasped than would a more voluminous collection of undigested and unrelated data.

Before turning to the pages of technical material which follow, we believe that the ideas behind the Government's housing program should be briefly reviewed†

There are several classes of housing accommodations necessary for rehousing for those who are in need of more desirable quarters. There is the class which can afford rents from $8 to $12 per room per month. These can be provided by private initiative without recourse to subsidy, and have been taken care of in the past by such projects as Radburn, Hillside Homes, Neighborhood Gardens, and the Carl Mackley Houses.

The second group constitutes the present problem. Housing authorities visualize as the man to be housed a worker, with wife and children, whose income is comparatively steady, although small, and who if he cannot afford new housing under present conditions can at least pay for what he gets. This type of tenant has an income of from $1,000 to $2,000 per year, mostly in the lower brackets of this range. To provide minimum decency accommodations for this class with rentals within its grasp some form of subsidy is required. Thirty-eight per cent of U. S. families had incomes from $1,000 to $2,000 in 1929. It has been shown that with few exceptions private initiative cannot provide decent minimum standard housing for most of this group.

The Housing Division's policy accordingly was set up on the basis of a 45% outright grant, the remainder to be amortized over a period of 60 years. It was felt that by so doing, the great need evident for this class of people could be dealt with.

The total housing need has been said by one housing executive to consist of 14,000,000 dwelling units in the next 10 years.

Real Property Inventory income data show that two-thirds of all families, both owner and tenant, earn less than $1,400-$1,500 per year, and that two-thirds of tenant families are below $1,300. Therefore, it appears that two-thirds of 14 million or 9 million units must be built for income groups below $1,500, but, as stated, a precise estimate is unnecessary. Modernization and justified subdivision of existing vacancies cannot, it is believed, meet the need.

In addition to the *need* for housing, the clearing away of slums and blighted areas is desirable from the standpoint of what these areas are now costing the taxpayers. During 1932, in a certain slum area in Cleveland, where 2.47% of the population of the city dwelt on 0.73% of the land area, the tax income was $225,035, whereas the total cost of maintaining the section was $1,972,437, or a net loss of $1,747,402. Likewise in a certain district in Indianapolis it has been found that taxpayers are spending every year for each person $27.29 as against $4 per person in other areas.

If we are convinced that the housing at present available in slum areas is inadequate and if, on the basis of arguments just presented, private owners pay their share of the expense in maintaining such areas with the consequent loss of their profit, then we can conclude that private enterprise, unaided, cannot provide adequate housing for the group of population most in need. In fact, the argument for a public housing program concludes with the claim that obviously less fortunate families cannot be housed in decent dwellings without some form of aid and that, local authorities not now being able to assume an immediate program, it falls to the responsibility of the Federal Government to assist in providing such housing. However, the present program is designed so as not to inhibit the best efforts of private enterprise, and PWA claims that there is no conflict between its program and any private program.

†Information in this article relating to the Government's plan on housing is based largely on a statement by A. R. Clas, Director of Housing, before the Senate Committee on Education and Labor, 74th Congress, and an address delivered by Charles E. Pynchon of PWA at Pennsylvania State College, April 17, 1936.

DESIGN PRACTICE IN PWA HOUSING

The method of procedure which the Housing Division of Public Works Administration has followed in furnishing heating for the various projects has been to contract with a consulting engineer or engineers with offices in the vicinity of the proposed project to design the system under the supervision and following the specifications of PWA engineers. Thus, the actual design work of all the heating systems in these projects has been done by private consulting engineers.

The large scale upon which many of the projects are being constructed has enabled PWA to take advantage of the economies of central heating, but in many cases group plants were used where such an arrangement was better suited to the general design. In order to give the reader a better idea of the size of these projects, a number of them are for between four and five thousand rooms with a simple heating plant having approximately one thousand boiler horsepower capacity.

With a view to pioneering the most efficient means of heating for large scale houses, the Mechanical Division of the Housing Division has, in many cases, proceeded along independent lines. The main idea behind all of its designs is to provide for installation of the most economical type steam generating and distributing equipment.

Steam Heating Practice

In all but a few cases the PWA housing projects are heated with steam—the larger projects having a central heating plant. On these large projects the usual practice is to generate steam at between 100 and 150 lb., and to reduce it in a primary pressure reducing station, located in the heating plant, to approximately 30 lb. This 30-lb. steam is then carried by steam mains enclosed in underground conduits or tunnels to the various groups of buildings in the project. The usual practice is to have this intermediate pressure steam carried to a heater room located in the basement of one of the buildings in the group, and then to reduce the pressure down to between 0 and 5 lb. by means of a secondary reducing station. Low pressure steam is then distributed to the various buildings of the group. In all cases the steam heating system is of the zone-controlled, two-pipe, upfeed type with a vacuum return.

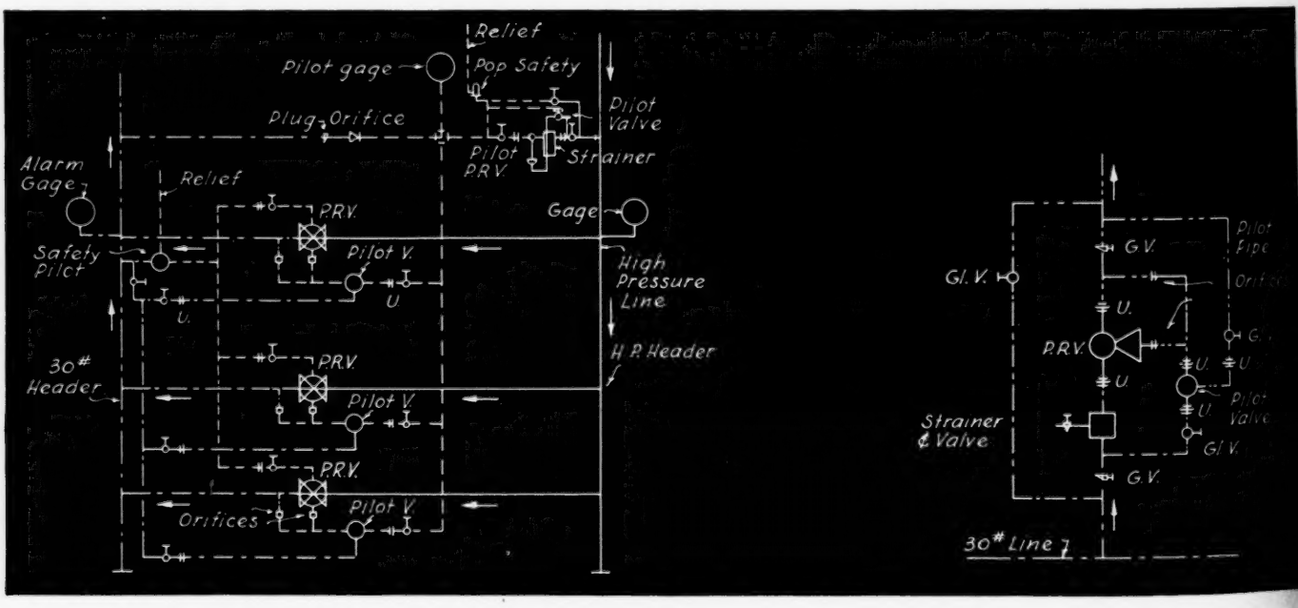
One vacuum pump usually takes care of a number of buildings. The discharge from the pump is carried back to the heating plant through a return line running in the same conduit as the steam main. In some cases where the buildings are located near the heating plant, low pressure steam (0 to 5 lb.) is piped directly from the heating plant to these buildings utilizing exhaust steam from the steam-driven equipment.

Pressure Reduction Practice

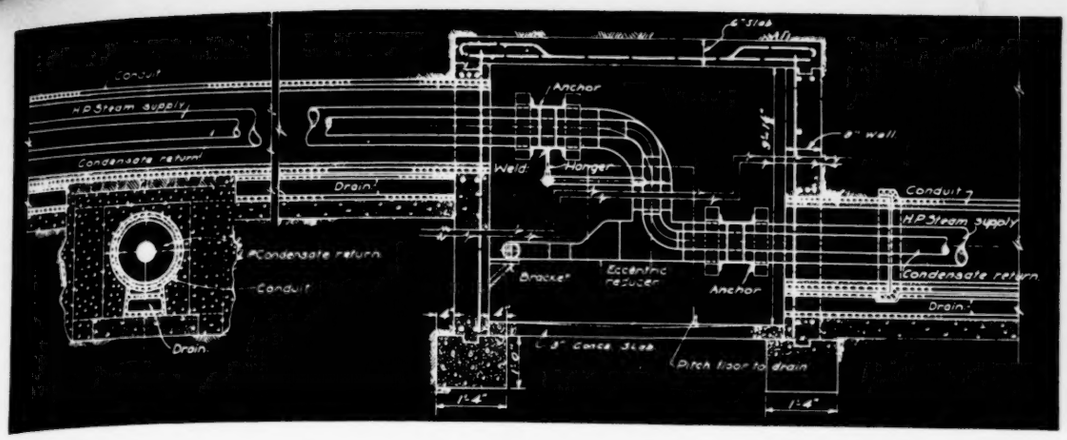
Since, on practically all the housing projects, steam is generated at either 100 or 150 lb. pressure, it is necessary to provide pressure reducing valves to lower the pressure to the point where it can be used in the heating system. The accompanying design of a typical pressure reducing station has been incorporated in the PWA Housing Division specifications because of its exceptional performance in former installations in private and Government practice.

The pressure reducing valve station which is shown is of the outside pilot control type with the intermediate pressure in the pilot piping, which insures a steady pressure on the diaphragm of the main pressure reducing valves, regardless of the pressure fluctuation in the high pressure steam supply main.

In brief, the operation of this type station is as follows: The main pressure reducing valves are normally in a closed position while the pilot valves are open and the pilot safety valve is closed. When steam is introduced into the high pressure line it flows through a small reducing valve into the pilot piping. If the pressure in the high pressure steam line is 100 lb., approximately 60 lb. pressure is maintained in the pilot piping. This intermediate pressure in the pilot piping acts on the diaphragm of the main pressure reducing valve overcoming the pressure of the spring which holds the valve closed, causing the valve to open. Steam then flows directly from the high pressure main to the low pressure main. When the



Two types of pressure reducing stations. (Left) A primary pressure reducing station which lowers the steam pressure fro approximately 100 lb. to 30 lb. This type of station is usually installed in the heating plant to reduce the pressure of th steam from the boiler pressure to the yard distribution pressure. (Right) Secondary reducing station which lowers th steam pressure from 30 lb. to the pressure used in the heating system. This type of station is usually installed in the bas ment of the building or group of buildings to be heated.



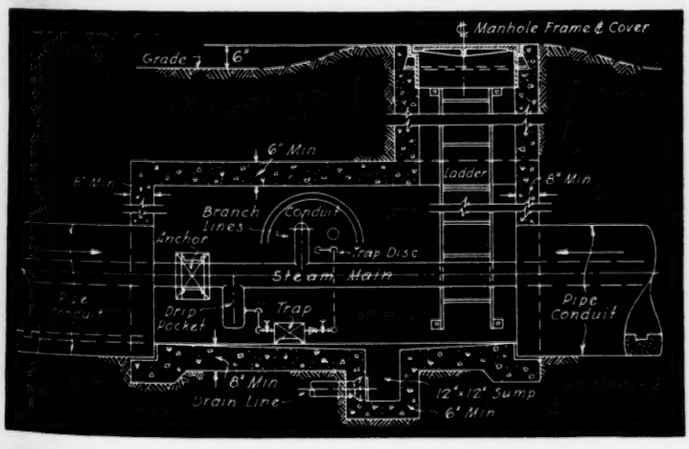
Typical underground piping detail in covered manholes.

predetermined pressure in the low side of this system is reached it has built up a pressure on the diaphragm of the pilot valve sufficient to overcome the spring setting on the pilot valve, causing it to close. This shuts off the steam supply to the diaphragm on the main pressure reducing valve. The steam which is trapped between the pilot valve and the diaphragm of the main pressure reducing valve is permitted to escape through an orifice, and be absorbed in a low pressure header. The spring within the main pressure reducing valve gradually closes the valve as the steam pressure falls.

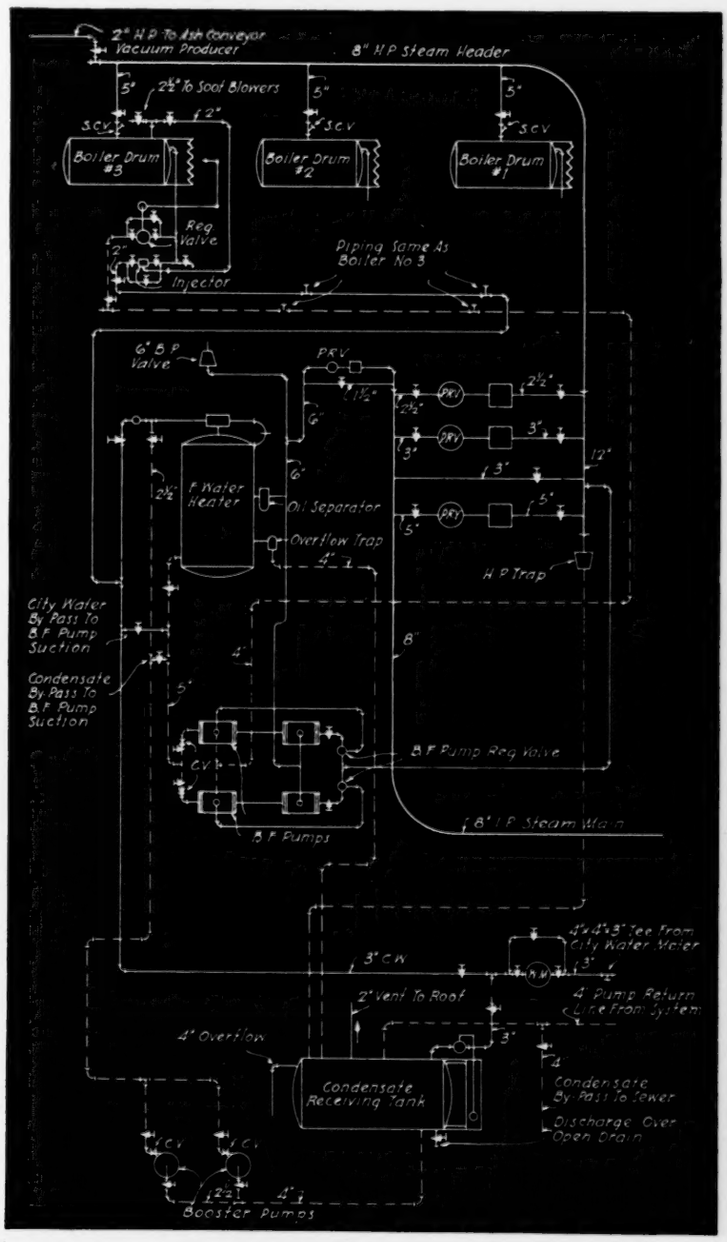
In the event that a pilot valve should fail to close, the increasing pressure (above the predetermined pressure) in the low pressure header is applied on the diaphragm side of the pilot safety valve. This causes the safety valve to open, relieving the pressure on the pilot pipe faster than it can build up in the steam chamber on the diaphragm of the main pressure reducing valve. It is to be noted that steam is introduced to a diaphragm in the main pressure reducing valve through an orifice. This orifice tends to retard the steam flow to the diaphragm creating a "cushion" effect on the valves. The reaction to this effect is an even moving valve eliminating sudden pulsations and "hunting" in the steam mains.

This method of pressure reduction furnishes extremely close regulation of the steam pressure in the low pressure main.

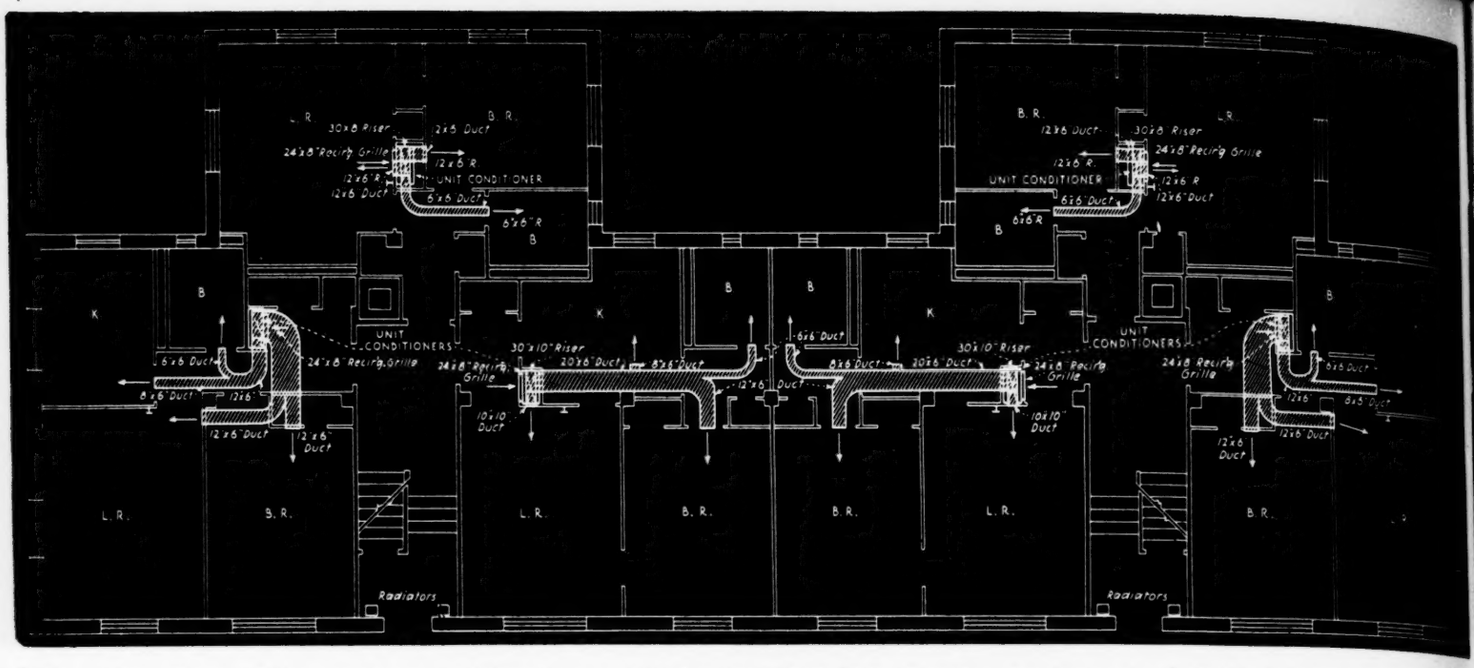
The diagram of the primary pressure reducing station as shown is a type which is normally installed in the power plant and is used to reduce the pressure of the steam from 100 to approximately 30 lb. This 30-lb. steam is then distributed to the various buildings or groups of buildings. In each building or group of buildings there is a secondary reducing station. The diagram of the piping of this station is shown at the right in the sketch. Steam from the distribution lines enters the station through the line marked 30 lb. It then flows through a pilot valve, which is normally held open by a spring, into a steam chamber in the main pressure reducing valve. A spring in this main pressure reducing valve normally holds the valve closed. As the steam pressure builds up on the diaphragm of the main pressure reducing valve it causes the valve to open and allows steam to flow through into the piping which connects with the heating system. As the pressure in the heating system piping reaches a predetermined point, it acts on the diaphragm of the pilot valve and causes this valve to close and shut off the steam pressure from the main pressure reducing valve. As the steam pressure on the diaphragm of the main pressure reducing valve is reduced the spring in the valve tends to close, shutting off the flow of steam from the 30-lb. line to the heating system main.



A typical manhole as installed at the junction of conduits. Condensation is collected in a pot and passes through a trap into a flash tank.



A schematic diagram of the arrangement of piping in the Brewster housing project, Detroit. This piping arrangement is not typical of all projects.



A floor plan of one of the apartment buildings in the Hill Creek, Philadelphia, housing development. Individual forced draft, unit type heaters are used to heat some of the apartments in this project. Recirculating air is drawn in through a large grille near the floor and distributed to the various rooms by means of the ductwork shown.

Hot Water Heating Practice

In some of the housing projects it was found necessary to install central hot water heating systems in place of central steam systems. This is true of two projects in Nashville, Tenn., and one in Atlantic City, N. J. A brief description of the installation in Atlantic City will serve to illustrate what PWA housing practice is on such systems.

Water is heated in large steel boilers to a temperature of approximately 230 F; the system is automatically maintained under a slight pressure to prevent the water from flashing into steam. Each hot water main is provided with an electrically-driven centrifugal pump for circulating the hot water. A spare pump unit is provided for each service. The temperature of the water in the heating system is automatically varied in accordance with the requirements of the outdoor temperature. This is accomplished by an outdoor control which automatically varies and mixes quantities of 230 F water taken directly from the boiler, and the cooler water returning from the heating system, resulting in a water temperature suited for that particular outdoor temperature. With 0 F outdoor temperature probably all water will be taken directly from the boilers and distributed at approximately 230 F. With rising outdoor temperatures the hot water temperature will be automatically lowered. To compensate for excessive water or sunlight the water temperature range may be manually adjusted to provide higher or lower temperatures.

In addition to the controls mentioned, automatic devices are provided to ensure equalized distribution of the heating system water to each building, and each radiator is further provided with a device to ensure equalized distribution within the building.

As far as is reasonably possible, the human element has been eliminated from the control of the operation of the plant. All controls are set and adjusted at the time the plant is started.

Fuel and Fuel-Burning Equipment

In designing the heating plants very careful consideration was given to the selection of fuel. Where coal was found to be the more economical fuel, the type of firing equipment and combustion controls installed is that best adapted for utilizing grades available at the lowest cost upon an evaluated B.t.u. basis. Where oil fuel or natural gas was found to be more economical the plant was equipped for its use in the most efficient manner, but in every instance provision has been made for storing and burning coal. The boilers are designed that it is possible economically to convert any of the oil or gas plants to burn coal, and vice versa.

$130 Million for Housing

The housing program with which the Public Works Administration is engaged is a national demonstration program of slum clearance and low-rent housing. Forty-nine projects in 35 cities in the United States and two of its insular possessions are in active construction. When completed these developments will cost an estimated $130 million and provide approximately 25,000 families of the low income group with sanitary living quarters.

Of the 49 projects, 11 are treated on pages 39 to 49, inclusive, and a twelfth, which has not yet reached a stage where complete details are available, is described on page 50. In addition there is on page 50 a list of the other projects with which the PWA is now concerned, excepting only those projects which are located outside of the United States proper.†

Of the sites requiring demolition, 21 have already been cleared (as of May 8). Demolition is proceeding on 15 others. Construction of foundations has been completed on one project and is under way on 23 others. General construction is under way on 11 projects. Landscaping has been completed on one project and bids have been accepted and proceed orders issued on four others.

The projects here described are those being built by the Public Works Administration and are not to be confused with projects under the sponsorship of the Federal Housing Administration. The FHA is also concerned with housing but more from the angle of providing adequate housing at reasonable mortgage rates for those desiring to own their own homes.

†Of these, one is located in San Juan, Puerto Rico, and consists of one group houses. There are three, all containing one-story group houses, in various parts of the Virgin Islands.

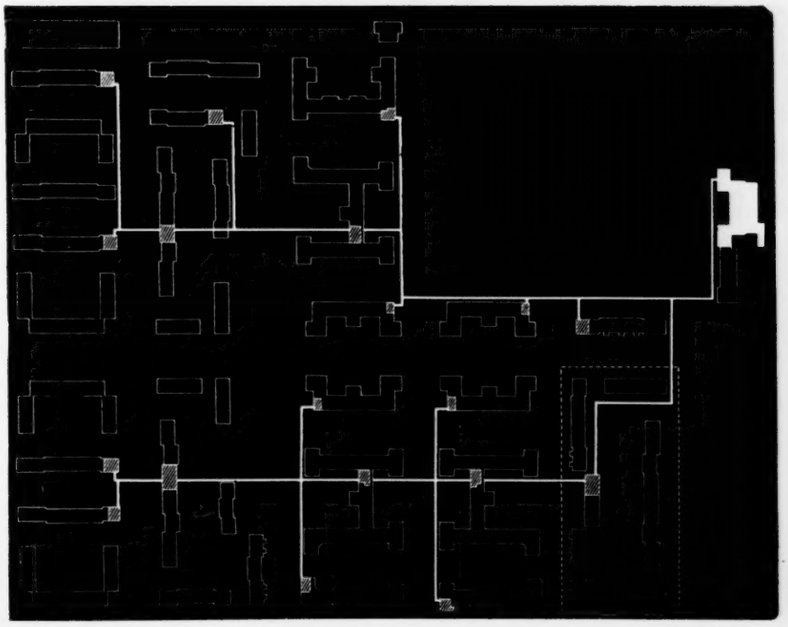
DETROIT

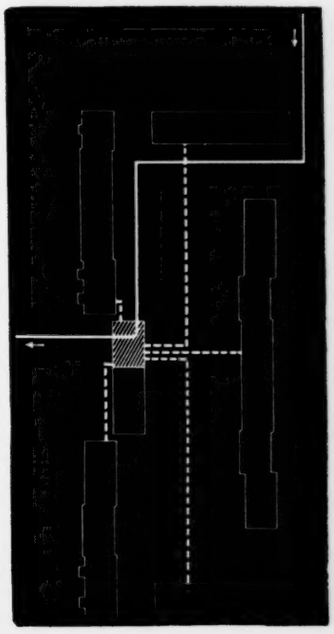
SPECIFICATIONS

NAME	Brewster
TOTAL COST OF PROJECT	$5,500,000
NUMBER OF BUILDINGS	23
NUMBER OF APARTMENTS	920
NUMBER OF ROOMS	3,129
TOTAL CUBAGE	9,500,000 cu. ft.
TOTAL FLOOR AREA	782,000 sq. ft.
PER CENT COMPLETED	Foundation bids opened May 25
WALL CONSTRUCTION	Brick and tile
HEIGHT	Three-story apartments, two-story group houses and flats
CONSULTING ENGINEER	George Wagschaw
BOILERS	3–300 hp.
TYPE	Cross drum, straight water tube
STEAM PRESSURE	Normal, 125 lb.
FUEL	Bituminous
FUEL BURNING EQUIPMENT	Spreader type stokers
HOT WATER CAPACITY	9,600 g.p.h.
PRESSURE OF STEAM IN MAIN	30 lb.
HEATING SURFACE, SQ. FT.	123,588
TYPE OF SURFACE, SQ. FT.	94,947 cast iron radiators; 7,983 convectors; 3,250 unit heaters; 17,408 exposed risers

HEAT DISTRIBUTION

Steam is generated normally at 125-lb. pressure by three 300-hp. cross drum, straight water tube boilers. They are fired with bituminous nut and slack coal by spreader type stokers. Steam for the heating system is reduced to 30 lb. by passing it through a primary reducing station in the heating plant. This intermediate steam then flows to a number of machine, or heater, rooms located at strategic points in the project. A secondary reducing station is located in each one of these rooms, and a secondary steam distribution system furnishes steam to nearby buildings. The heating system in each building is a zone-controlled two-pipe, upfeed, low pressure vacuum return system. The vacuum pumps are located in the machine rooms. Approximately 124,000 sq. ft. of heating radiator surface is provided throughout the project. One 4-in. main returns the condensate from the pump discharges to the boiler plant.





PLOT PLAN

Conduit lines contain steam supply and returns to and from heater rooms. (Left) Plot plan showing primary distribution. (Right) Typical block showing steam distribution from heater room to adjacent buildings.

CAMDEN

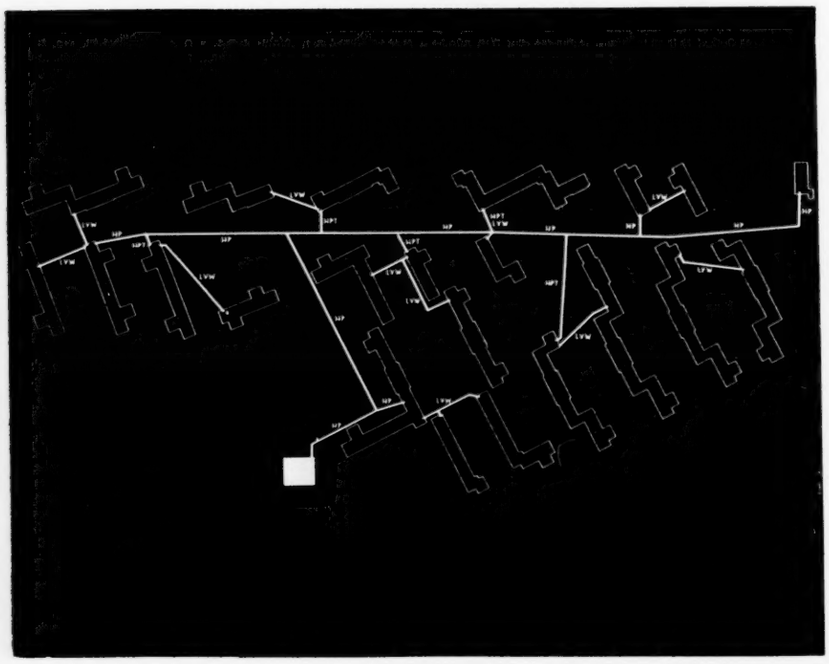
Aerial photo of Westfield Acres, May 9, by Parrish & Read, Inc. Courtesy Turner Construction Co.

HEAT DISTRIBUTION

Steam is generated normally at 100-lb. pressure by three 220-hp. boilers. They are of the three-drum, low head, bent tube type, and are fired by oil burners burning No. 6 Bunker C oil. After the steam, which is to be used for heating, is reduced in a primary reducing station to 30 lb., it is distributed to the various buildings by a 10-in. main. In a number of cases, the secondary reducing station which lowers the steam pressure to between 0 and 5 lb., supplies low pressure steam for the surrounding buildings, while in other cases it supplies only the steam to the building in which it is housed. The heating system in each building is a zone-controlled, two-pipe, upfeed low pressure vacuum return system. Each building has its domestic hot water generating unit. Approximately 76,000 sq. ft. of radiator surface is used for heating this project. Of this, 64,000 sq. ft. is in cast iron radiators, and 12,000 in exposed risers.

SPECIFICATIONS

NAME
Westfield Acres
SIZE
25 acres
TOTAL COST OF PROJECT
$3,000,000
NUMBER OF BUILDINGS
22
NUMBER OF APARTMENTS
598
NUMBER OF ROOMS
2,200
CUBAGE
Living units, 4,050,000 cu. ft.; all others, 1,350,000 cu. ft.
TOTAL FLOOR AREA
Living units, 450,000; all other, 150,000
PER CENT COMPLETED
Foundations, 30%
WALL CONSTRUCTION
Brick and tile
HEIGHT OF BUILDINGS
Three stories
HEIGHT OF STORIES
9 ft.
CONSULTING ENGINEER
Lawrence Moody
BOILERS
Number, 3; size, 220 hp.
TYPE
3 drum, low head, bent tube
STEAM PRESSURE
Normal operating, 100 lb.
FUEL
No. 6, bunker C crude oil
FUEL BURNING EQUIPMENT
Oil burners
HOT WATER CAPACITY
7,200 g.p.h.
OTHER LOADS ON BOILERS
None
PRESSURE OF STEAM IN MAIN
30 lb.
HEATING SURFACE, SQ. FT.
76,236
TYPE OF SURFACE
64,191 sq. ft. cast iron radiator; 12,045 sq. ft. posed risers
TYPE HEATING SYSTEM
Steam, vacuum return



PLOT PLAN

H—high pressure steam main; L—low pressure steam m
P—pump return; V—vacuum return; W—domestic hot w
supply and return.

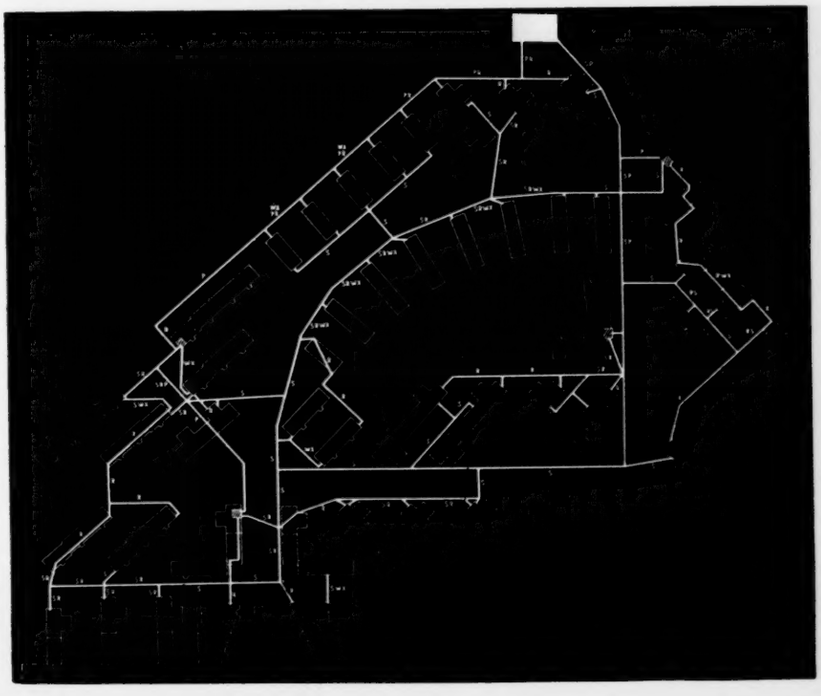
CLEVELAND

SPECIFICATIONS

NAME
West Side
SIZE
22 acres
TOTAL COST OF PROJECT
$3,800,000
NUMBER OF BUILDINGS
44
NUMBER OF APARTMENTS
620
NUMBER OF ROOMS
2,311
TOTAL CUBAGE
Living units, 6,165,140 cu. ft.;
all others, 2,022,510 cu. ft.
TOTAL FLOOR AREA
Living quarters, 460,300 sq. ft.;
all others, 197,400 sq. ft.
PER CENT COMPLETED
Work proceeding
WALL CONSTRUCTION
Brick and tile
HEIGHT
Two and three story
HEIGHT OF STORIES
9 ft.
CONSULTING ENGINEERS
Mayer and Valentine
BOILERS
Number, three; size, 250 hp.
TYPE
Cross drum, straight water tube
STEAM PRESSURE
Normal, 100 lb.
FUEL
Bituminous nut and slack
FUEL BURNING EQUIPMENT
Spreader type stokers
HOT WATER CAPACITY
7,500 g.p.h.
OTHER LOADS ON BOILERS
None
PRESSURE OF STEAM IN MAIN
30 lb.
HEATING SURFACE
110,075 sq. ft.
TYPE HEATING SYSTEM
Steam, vacuum returns
TYPE OF SURFACE
86,920 sq. ft. cast iron radiators; 8,685 sq. ft. convectors; 9,378 sq. ft. unit heaters; 5,092 sq. ft. exposed risers

HEAT DISTRIBUTION

Steam is generated at 100-lb. pressure by three 250-hp. boilers. They are of the cross drum, straight water tube type and are fired by spreader type stokers burning bituminous nut and slack coal. Steam for the heating system is reduced by means of a primary reducing station located in the heating plant to yard distribution pressure (30 lb.), and it is then carried from the heating plant in a 10-in. underground steam main. One striking feature of the yard distribution system is a rise in elevation of approximately 80 ft. from the heating plant to the uppermost end of the property. The buildings are located on ground which is terraced in many directions. This situation resulted in an unusual network of cross-supply mains. This intermediate steam is distributed to each building, and a secondary reducing station located in each building is used to supply low pressure steam for the heating system. The heating system in each building is a two-pipe, upfeed, low pressure vacuum return system. Two 3-in. pump discharge lines and one 4-in. vacuum return line carry the condensate back to the boiler house. In many cases because of ground contours, domestic hot water is supplied to a group of buildings from a centrally located hot water generating unit located in one of the basements of the group.



PLOT PLAN

S—steam main; R—vacuum return main; P—pump discharge main; W—domestic hot water supply line; X—domestic hot water return line.

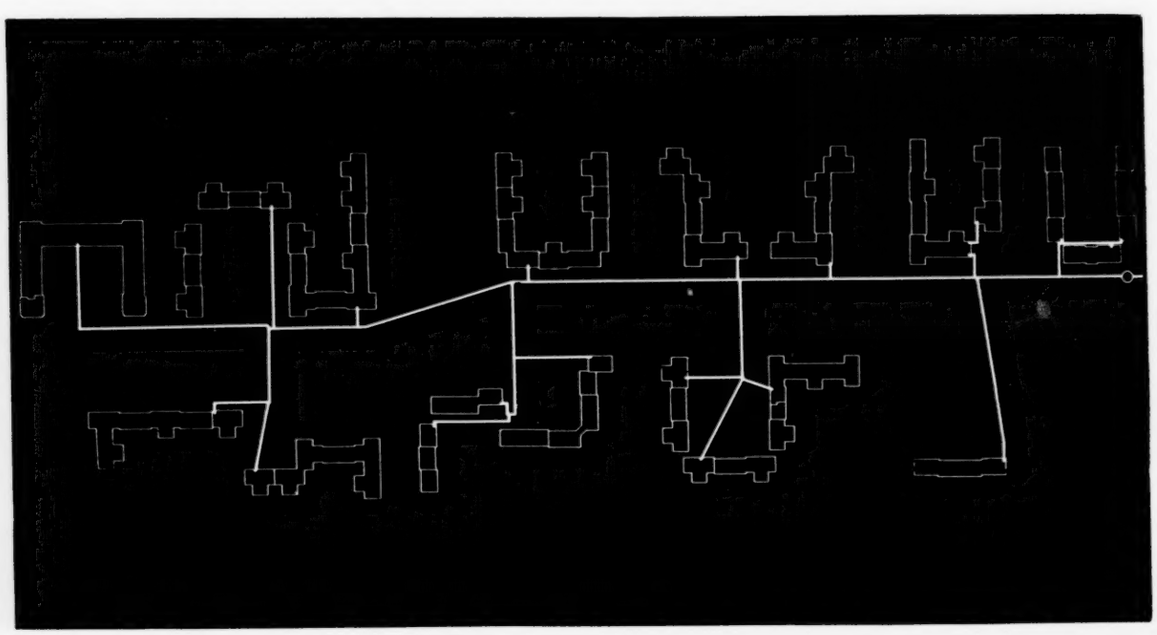
ATLANTA

HEAT DISTRIBUTION

On this project steam is purchased from a local utility. Three manholes are provided at the boundary of the project. The first manhole houses the equipment of the local utility, while the second contains the necessary metering orifices, and the third the primary reducing station which lowers the pressure to 30 lb. One 12-in. main carries the steam from the reducing station to the various buildings. Each building has a secondary reducing station to lower the pressure to between 0 and 5 lb. The heating system in each building is a two-pipe, upfeed, low pressure, vacuum return system. Zone control is provided in each building. There are approximately 67,000 sq. ft. of cast iron direct radiator surface, 8,800 sq. ft. of unit heaters, and 6,800 in exposed risers. The pumps which are used to maintain the vacuum in the heating system discharge the condensate through heat exchangers to the sewer.

SPECIFICATIONS

NAME	Techwood Homes
SIZE	25 acres
TOTAL COST OF PROJECT	$3,100,000
NUMBER OF BUILDINGS	34
NUMBER OF APARTMENTS	603
NUMBER OF ROOMS	2,124
TOTAL CUBAGE	Living units, 3,661,50 sq. ft.; all others, 1,913,090 sq. ft.
TOTAL FLOOR AREA	Living quarters, 40 833 sq. ft.; all other 213,963 sq. ft.
PER CENT COMPLETED	Finished
WALL CONSTRUCTION	Brick and tile
HEIGHT	Two and three story
HEIGHT OF STORIES	9 ft.
CONSULTING ENGINEER	L. C. Boland, Jr.
STEAM SUPPLY	Steam purchased fro utility
HOT WATER CAPACITY	13,000 g.p.h.
PRESSURE OF STEAM IN MAINS	30 lb.
HEATING SURFACE	82,908 sq. ft.
TYPE OF SURFACE	67,309 sq. ft. cast ir radiators; 8,800 sq. unit heaters; 6,799 ft. exposed risers



PLOT PLAN

BOSTON

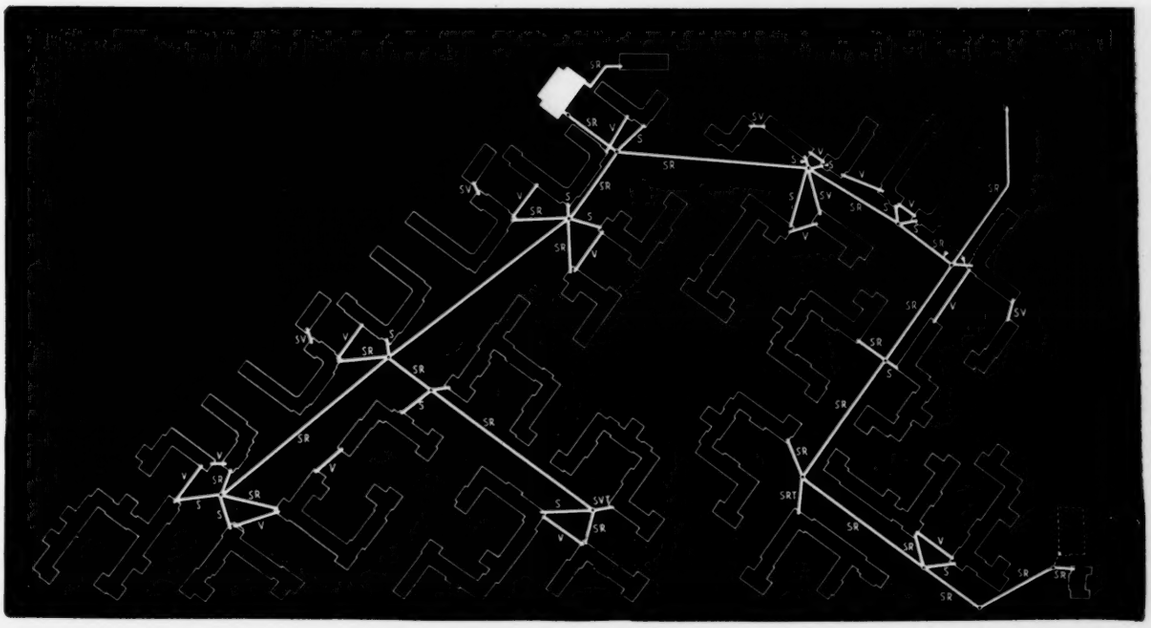
SPECIFICATIONS

NAME	Old Harbor Village
SIZE	33 acres
TOTAL COST OF PROJECT	$6,000,000
NUMBER OF BUILDINGS	34
NUMBER OF APARTMENTS	1,016; 3,912 rooms
TOTAL CUBAGE	6,942,000 cu. ft.
TOTAL FLOOR AREA, SQ. FT.	Living Units, 771,000
PER CENT COMPLETED	Foundations, 20%
HEIGHT	2 and 3 stories
CONSULTING ENGINEER	Jackson & Moreland
BOILERS	3–350 hp.
TYPE	Four drum.
FUEL	Semi-bituminous nut and slack or No. 6, bunker C oil
HOT WATER CAPACITY	12,500 g.p.h.
OTHER LOADS ON BOILERS	Turbine auxiliaries
FUEL BURNING EQUIPMENT	Multi-retort, inclined grate, underfeed stokers or pressure, orifice type oil burners
TYPE OF SURFACE	Cast iron, 128,964 sq. ft.; convectors, 2,408 sq. ft.; unit heaters, 3,000 sq. ft.; exposed risers, 7,111 sq. ft.

HEAT DISTRIBUTION

Steam is generated at approximately 125 lb. in order to take care of the operation of pumps and other steam-driven equipment. Three 350-hp. boilers fired by either underfeed stokers or pressure type oil burners are used. A turbine-driven feed water pump is provided for the heavy water loads, and a half-capacity turbine-driven pump for moderate loads. For extremely light loads which are encountered during the summer a small motor-driven triplex pump is used.

Steam which is to be used for heating the various buildings is reduced in a primary pressure reducing station to approximately 30 to 50 lb. pressure. It then flows through two 8-in. and one 2-in. steam mains enclosed in underground conduit to the various buildings. In each building there is a secondary reducing station which lowers the pressure to between 0 and 5 lb. The heating system in each building is a zone-controlled, two-pipe, upfeed, low pressure, vacuum return system installed to operate on a vacuum of not less than 5½ in. of mercury at the pump. Sixteen vacuum pumps are used to maintain the vacuum in the heating systems to suit the groupings of the 34 buildings.



PLOT PLAN

S—steam main; V—vacuum return main; R—pump return main; T—high pressure trap discharge main.

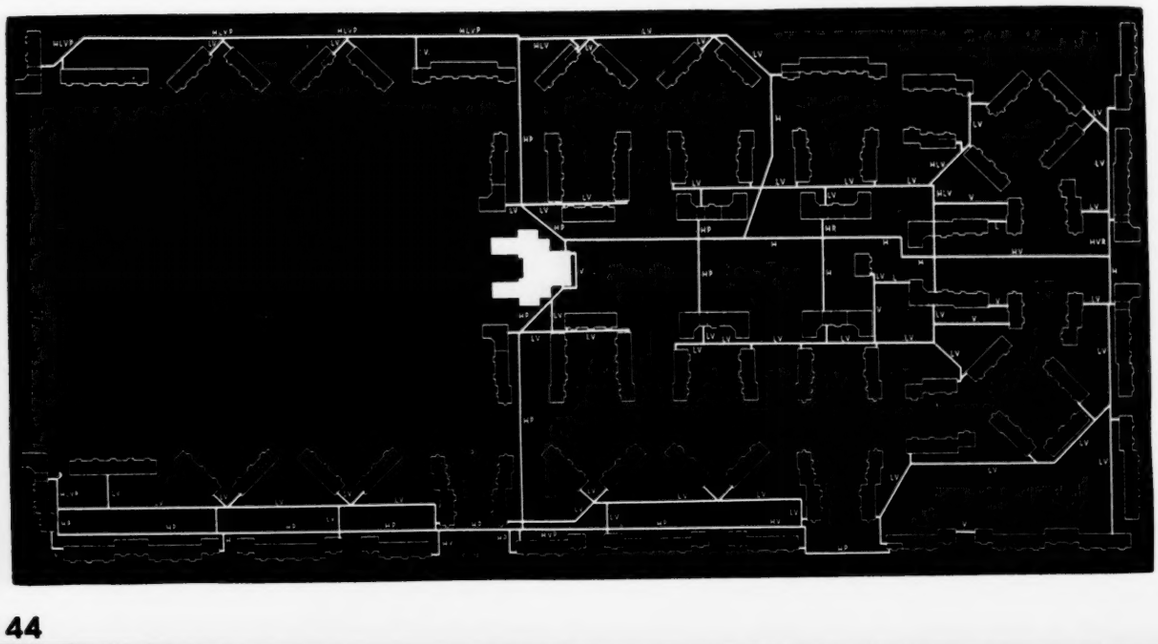
BUFFALO

HEAT DISTRIBUTION

Steam is generated at 100-lb. pressure by three 250-hp., three-drum, bent tube boilers. They are fired by single retort underfeed stokers burning bituminous nut and slack coal. Steam for the nearby buildings is reduced in a double pressure reducing station located in the heating plant to approximately 5 lb. The more distant buildings are supplied with 30-lb. steam which is obtained by passing 100-lb. steam through a primary reducing station in the heating plant. One 8-in. and one 6-in. main carry the intermediate pressure steam, and two 5-in. steam mains carry the low pressure steam to the various buildings. In some cases 30-lb. steam is carried directly to the building and a secondary reducing station lowers the pressure to 5 lb. In other cases, one centrally located secondary reducing station supplies enough low pressure steam for a number of buildings. The heating system in each building is a zone-controlled, two-pipe, upfeed, low pressure, vacuum return system. Each building does not have its own vacuum pump, but they are so located that one pump takes care of a number of nearby buildings.

SPECIFICATIONS

NAME	Kenfield
SIZE	65 acres
TOTAL COST OF PROJECT	$4,500,000
NUMBER OF BUILDINGS	62
NUMBER OF APARTMENTS	658
NUMBER OF ROOMS	2,756
TOTAL CUBAGE	7,126,000 cu. ft.
TOTAL FLOOR AREA	586,000 sq. ft. (livin units)
PER CENT COMPLETED	Work proceeding
WALL CONSTRUCTION	Brick and tile
HEIGHT	One, two, three story
HEIGHT OF STORIES	9 ft.
CONSULTING ENGINEER	H. M. Davidson
BOILERS	Number — three; siz —250 hp.
TYPE	Three drum, bent tu
STEAM PRESSURE	Normal, 100 lb.
FUEL	Bituminous nut a slack
FUEL BURNING EQUIPMENT	Single retort, und feed stokers
HOT WATER CAPACITY	7,900 g.p.h.
OTHER LOADS ON BOILERS	Turbine auxiliaries
PRESSURE OF STEAM IN MAINS	30 lb.
HEATING SURFACE	103,625 sq. ft.
TYPE OF SURFACE	78,427 sq. ft. cast i radiators; 7,247 sq. exposed risers
TYPE HEATING SYSTEM	Steam, vacuum ret



PLOT PLAN

H—high pressure steam
L—low pressure steam
V—vacuum return ma
P—pump return mai

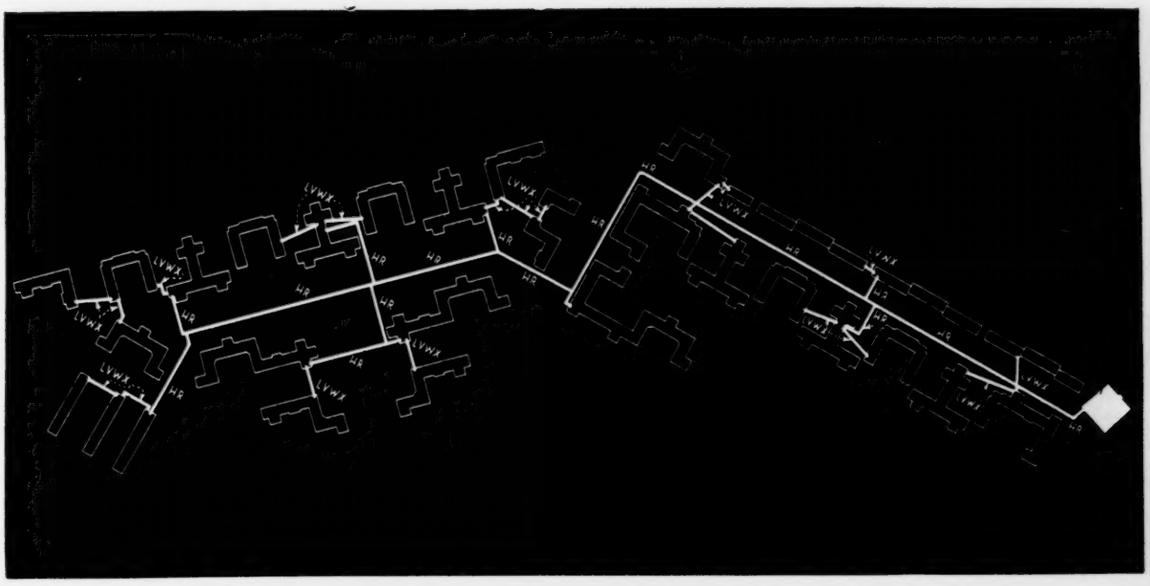
CHICAGO

SPECIFICATIONS

NAME	Julia C. Lathrop Homes
SIZE	35 acres
TOTAL COST OF PROJECT	$6,000,000
NUMBER OF BUILDINGS	31, 975 rooms
NUMBER OF APARTMENTS	3419
TOTAL CUBAGE	Living quarters, 6,800,000 cu. ft.; all others, 1,940,000 cu. ft.
TOTAL FLOOR AREA	Living quarters, 755,200 sq. ft.; all others, 269,140 sq. ft.
PER CENT COMPLETED	Work proceeding
WALL CONSTRUCTION	Brick and tile
HEIGHT	Three-story apartments; two-story flats and group houses
HEIGHT, STORIES	9 ft.
CONSULTING ENGINEER	Martin C. Schwab
BOILERS	Number, three; size, 370 h.p.
TYPE	4 drum, air cooled walls
STEAM PRESSURE	Operating, 125 lb.
FUEL	Illinois bituminous nut and slack
FUEL BURNING EQUIPMENT	Chain grate, turbine drive
HOT WATER CAPACITY	Not available
OTHER LOADS ON BOILERS	Turbine auxiliaries
PRESSURE OF STEAM IN MAIN	30 lb.
HEATING SURFACE	179,222 sq. ft.
TYPE OF SURFACE	157,091 sq. ft. cast iron radiators; 13,821 sq. ft. convectors; 1,900 sq. ft. pipe coils; 6,400 sq. ft. exposed risers

HEAT DISTRIBUTION

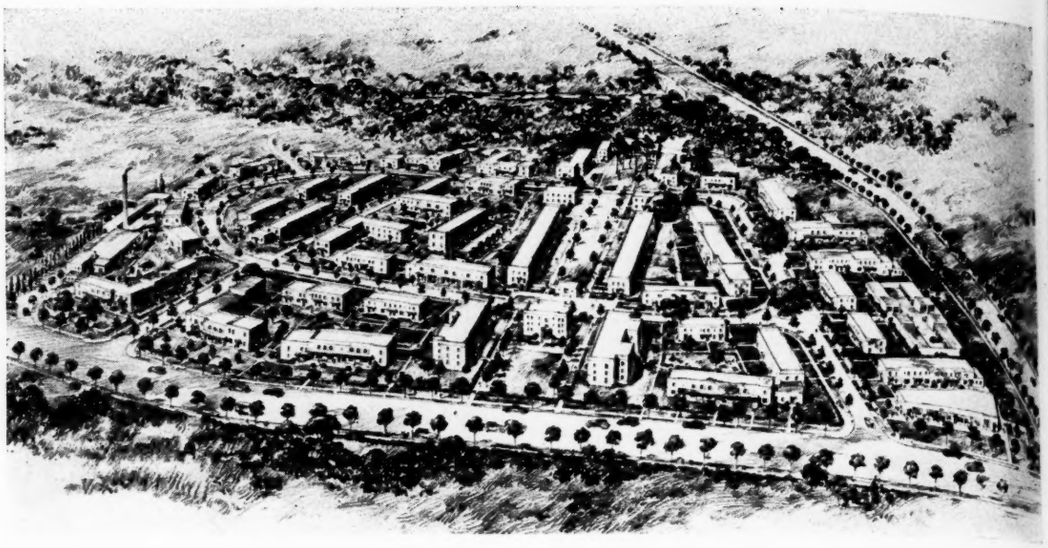
Steam is generated normally at 125 lb. pressure. Three 370-hp. boilers of the four-drum, air cooled wall type, fired by chain grate turbine drive stokers are used to generate the steam. Bituminous nut and slack coal is used. A primary reducing pressure station located in the central heating plant reduces the pressure of the steam used for heating to approximately 30 lb. A 12-in. steam main in an underground conduit carries the steam from the heating plant to a number of machine rooms located throughout the project. Secondary reducing stations located in these machine rooms lower the steam pressure to between 0 and 5 lb. Also located in these machine rooms are hot water heaters for supplying domestic hot water to nearby buildings. Underground conduits are used for carrying the low pressure steam main and domestic hot water and return main to and from nearby buildings. The heating system in each building is a two-pipe, upfeed, low pressure, vacuum return system. The vacuum pumps for maintaining a vacuum in the building heating system are also located in the machine rooms.



PLOT PLAN

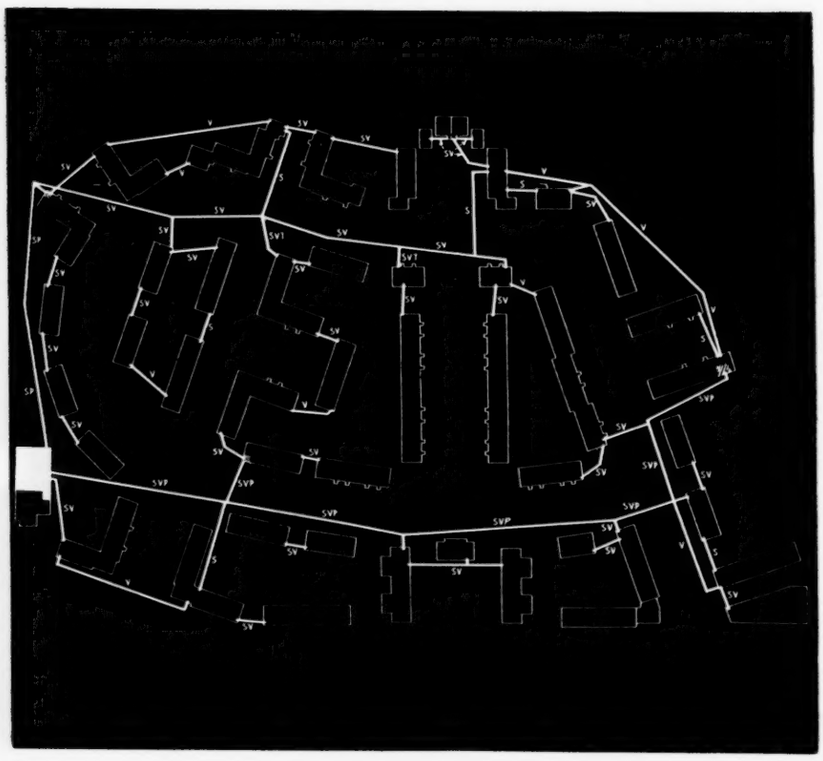
H—high pressure steam main; L—low pressure steam main; V—vacuum return main; R—pump discharge main; W—domestic hot water supply main; X—domestic hot water return main.

PHILADELPHIA



HEAT DISTRIBUTION

Steam is generated normally at 100-lb. pressure by three 130-hp. boilers of the three-drum, low head, bent tube type. Single retort underfeed stokers burning semi-bituminous nut and slack coal are used to fire the boilers. A primary reducing station located in the heating plant reduces the steam which is to be used for heating to 30 lb. After being reduced the steam flows through two 8-in. and one 4-in. steam mains to the 38 buildings. In each building, or in some cases in each group of buildings, there is located a secondary reducing station which lowers the pressure to between 0 and 5 lb. The heating system in each building is a two-pipe, upfeed, low pressure, vacuum return system. Approximately 45,000 sq. ft. of heating surface is provided for the 38 buildings. Of these, about 35,000 sq. ft. is cast iron radiator surface, 2,800 sq. ft. convector surface, 4,200 sq. ft. of unit conditioners (see illustration on page 38), and 970 sq. ft. of unit heaters. The condensate is returned to the power plant through two 2½-in. pump discharge lines, and one 3-in. vacuum return line.



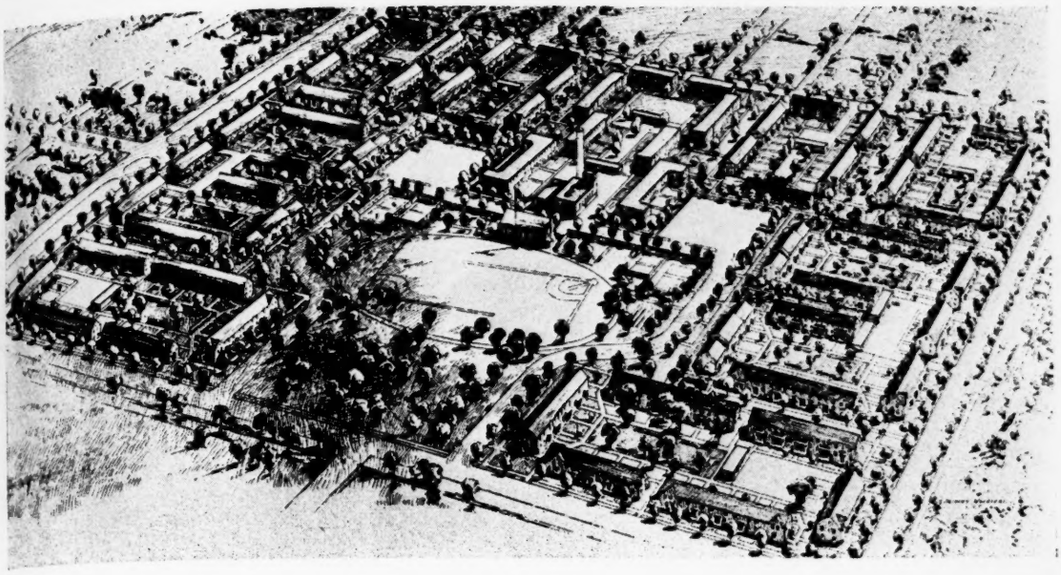
PLOT PLAN

S-steam main; V-vacuum return main; P-pump return mai

SPECIFICATIONS

NAME
Hill Creek
SIZE
24 acres
TOTAL COST OF PROJECT
$1,800,000
NUMBER OF BUILDINGS
38
NUMBER OF APARTMENTS
258
TOTAL CUBAGE
Living quarters, 1,875,000 sq. ft.; all others, 833,000 sq. ft.
TOTAL FLOOR AREA
Living quarters, 209,800 sq. ft.; all others, 105,500 sq. ft.
PER CENT COMPLETED
Foundations, 30%
WALL CONSTRUCTION
Brick and tile
HEIGHT
Two stories
HEIGHT OF STORIES
9 ft.
CONSULTING ENGINEER
A. Ernest Dambly
BOILERS
Number—three; size—130 hp.
TYPE
Three drum, low head, bent tube
STEAM PRESSURE
Normal, 100 lb.
FUEL
Pennsylvania semi-bituminous nut and slack
FUEL BURNING EQUIPMENT
Single retort, underfeed stokers
HOT WATER CAPACITY
4,000 g.p.h.
OTHER LOAD ON BOILERS
None
PRESSURE OF STEAM IN MAINS
30 lb.
HEATING SURFACE
44,729 sq. ft.
TYPE OF SURFACE
34,787 sq. ft. cast iron radiators; 2,780 sq. ft. convectors; 4,280 sq. ft. unit conditioners; 970 sq. ft. unit heaters
TYPE HEATING SYSTEM
Steam, vacuum return

MILWAUKEE

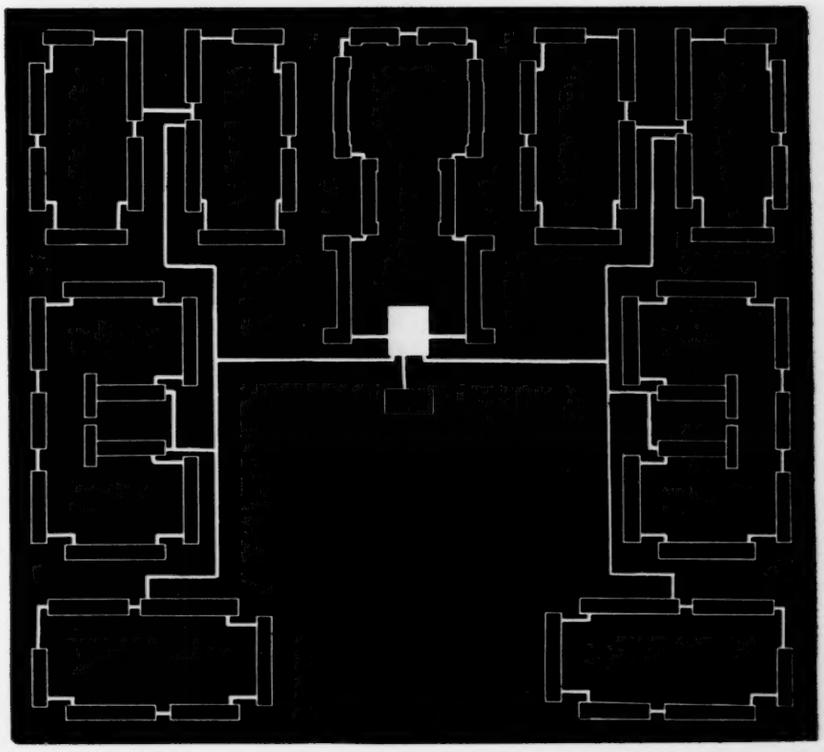


SPECIFICATIONS

NAME
Parklawn
SIZE
42 acres
TOTAL COST OF PROJECT
$2,800,000
NUMBER OF BUILDINGS
62
NUMBER OF APARTMENTS
518
NUMBER OF ROOMS
2,018
TOTAL CUBAGE
Living units, 3,615,500 cu. ft.; all other, 2,449,700 cu. ft.
TOTAL FLOOR AREA
Living units, 427,923 sq. ft.; all other, 249,721 sq. ft.
PER CENT COMPLETED
Work proceeding
WALL CONSTRUCTION
Brick and tile
HEIGHT
One, two, three stories
HEIGHT OF STORIES
9 ft.
CONSULTING ENGINEER
Jos. H. Volk
BOILERS
Number—three; size—200 hp.
TYPE
Three drum, low head, bent tube
STEAM PRESSURE
Normal, 125 lb.
FUEL
Bituminous nut and slack
FUEL BURNING EQUIPMENT
Spreader type stokers
HOT WATER CAPACITY
6,200 g.p.h.
OTHER LOADS ON BOILERS
None
PRESSURE OF STEAM IN MAINS
30 lb.
HEATING SURFACE
80,414 sq. ft.
TYPE OF SURFACE
69,520 sq. ft. cast iron radiators, 5,445 sq. ft. convectors, 1,620 sq. ft. unit heaters, 3,829 sq. ft. exposed risers
TYPE OF HEATING SYSTEM
Steam, vacuum return

HEAT DISTRIBUTION

Steam is generated normally at 125-lb. pressure by three 200-hp. boilers. The boilers are of the three-drum, low head, bent tube type, and are fired by spreader type stokers burning bituminous nut and slack coal. The steam for heating the various buildings passes through a primary reducing station located in the central heating plant and is reduced to approximately 30 lb. Five steam mains ranging in size from 5 to 8 in. distribute the steam to the nine blocks of buildings making up this development. Steam lines to the blocks are housed in underground conduits, while the lines connecting the individual buildings in each block are in tunnels which are also used as passageways. Before passing into the heating system the steam is again reduced in a secondary reducing station to between 0 and 5 lb. The heating system is a zone-controlled, two-pipe, upfeed, low pressure, vacuum return system. The condensate and vapors from all of the buildings in each block flow through a central vacuum pump located in one of the basements. The discharges from these pumps are carried back to the central heating plant, in most cases, through the conduit which houses the supply main.



PLOT PLAN

STAMFORD

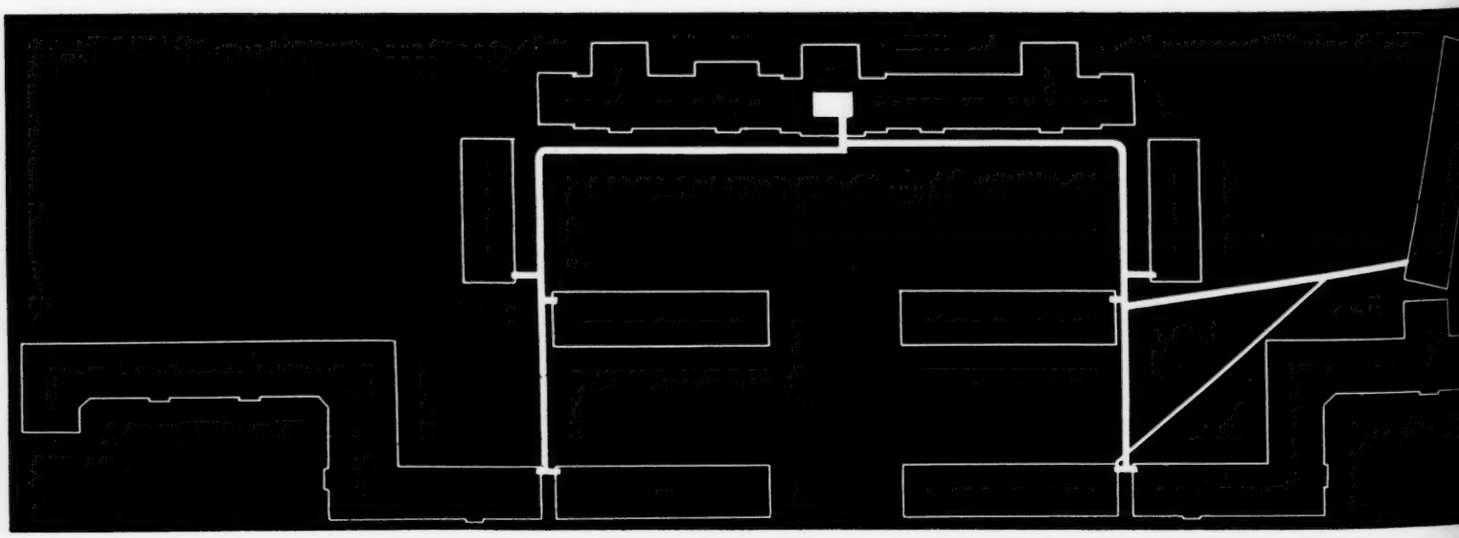
HEAT DISTRIBUTION

Steam is generated at 15-lb. pressure in two 90-hp. straight water-tube, single cross drum boilers which are fired by oil burners using Bunker C oil. Besides supplying steam for the heating system the boilers supply approximately 2,000 gal. per hr. of hot water for domestic use. The steam leaves the boiler room in an 8-in. underground main, and is distributed to the various buildings. The pressure in the steam main varies between 0 and 10 lb., depending upon the outside weather conditions. The heating system in each building is a two-pipe, upfeed, low pressure, vacuum return system. Approximately 22,000 sq. ft. of radiator surface are contained in the 10 buildings. About 19,600 sq. ft. of this surface is in the form of cast iron radiators, 580 sq. ft. in unit heaters, and 1,700 sq. ft. in exposed risers.

SPECIFICATIONS

NAME	Fairfield Court
SIZE	5 acres
TOTAL COST OF PROJECT	$800,000
NUMBER OF BUILDINGS	10
NUMBER OF APARTMENTS	154
NUMBER OF ROOMS	535
TOTAL CUBAGE	1,480,000 cu. ft.
TOTAL FLOOR AREA	106,600 sq. ft.
PER CENT COMPLETED	Foundations, 87%
WALL CONSTRUCTION	Brick and tile
HEIGHT	Three-story apartments; one- and two-story group houses
CONSULTING ENGINEER	Percival L. Davis
BOILERS	Number, two; size 90 h. p.
TYPE	Straight water tube with single cross drum
STEAM PRESSURE	15 lb.
FUEL	No. 6, bunker C oil
FUEL BURNING EQUIPMENT	Rotating nozzle burners, semi-automatic
HOT WATER CAPACITY	2,000 g.p.h.
OTHER LOADS ON BOILERS	None
HEATING SURFACE, SQ. FT.	21,954
TYPE OF SURFACE	19,672 sq. ft. cast iron radiators 580 sq. ft. unit heaters 1,702 sq. ft. exposed risers
TYPE HEATING SYSTEM	Steam, vacuum return
PRESSURE OF STEAM IN MAINS	0 to 10 lb.

PLOT PLAN



ATLANTIC CITY

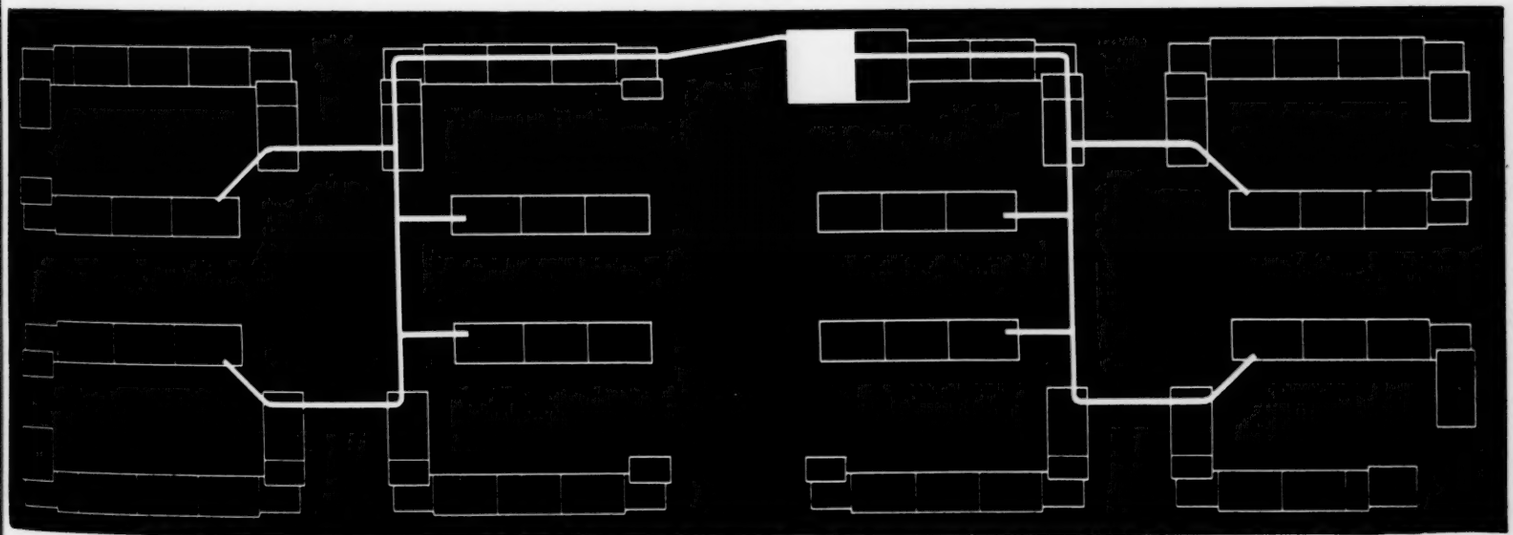
SPECIFICATIONS

NAME	Stanley S. Homes Village
SIZE	8 acres
TOTAL COST OF PROJECT	$1,700,000
NUMBER OF BUILDINGS	16
NUMBER OF APARTMENTS	277
NUMBER OF ROOMS	982
TOTAL CUBAGE	Living quarters, 1,731,820 cu. ft.; all other, 483,463 cu. ft.
TOTAL FLOOR AREA	Living quarters, 192,424 sq. ft.; all others, 92,542 sq. ft.
PER CENT COMPLETED	10%
WALL CONSTRUCTION	Brick and tile
HEIGHT	Two and three story
HEIGHT OF STORIES	9 ft.
CONSULTING ENGINEER	Sidney B. Strouse
BOILERS	Number — three; size —150 hp.
TYPE	H.R.T.
WATER TEMPERATURE	Hot water 240 F max.
FUEL	Bituminous nut and slack
FUEL BURNING EQUIPMENT	Single retort, underfeed stokers
SERVICE HOT WATER	3 000 g.p.h.
HEATING SURFACE, SQ. FT.	38,602
TYPE OF SURFACE	37,843 sq. ft. cast iron radiators; 759 sq. ft. exposed risers
TYPE HEATING SYSTEM	Hot water

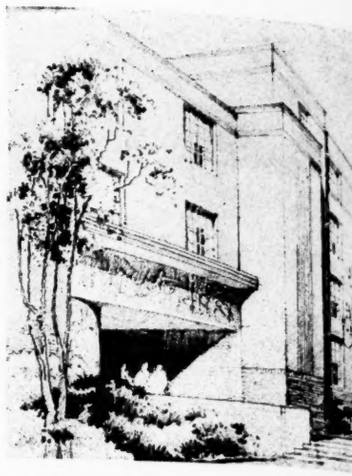
HEAT DISTRIBUTION

This project is heated by means of a forced hot water system. The water is heated to a temperature of 230 F by three 150-hp. steel boilers designed to operate at 150% of rating. Two boilers will normally carry the load, leaving the third unit as a spare. Boilers are stoker fired, and the operation entirely automatic. The hot water main to each block of buildings has a 400 g.p.m. motor-driven centrifugal pump. The temperature of the water for the heating systems is automatically controlled according to the requirements of the outdoor temperature. This is accomplished by means of an outdoor control which mixes quantities of 230 F water with cooler water returning from the heating systems, resulting in a water temperature suited for that particular outdoor temperature. When the outdoor temperature is at zero, probably all the water will be taken directly from the boiler and distributed at 230 F. In addition to the controls mentioned, automatic devices are provided to ensure equalized distribution of the heating system water to each building, and each radiator is further provided with adjustments to ensure equalized distribution within the building.

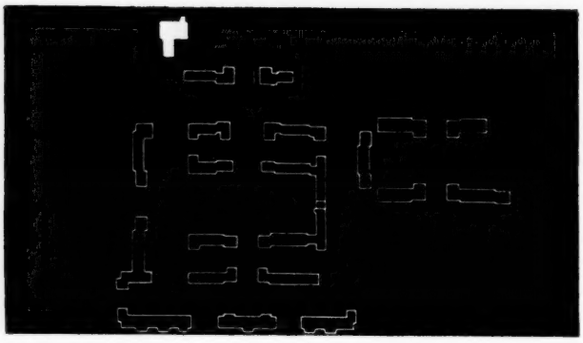
PLOT PLAN



WASHINGTON



PLOT PLAN



SPECIFICATION

NAME	Langston
SIZE	14 acres
TOTAL COST OF PROJECT	$1,600,000
NUMBER OF BUILDINGS	20
NUMBER OF APARTMENTS	317
NUMBER OF ROOMS	1,089
TOTAL CUBAGE	2,360,000 cu. ft.
TOTAL FLOOR AREA	262,000 sq. ft., living quarters
PER CENT COMPLETED	Work proceeding
WALL CONSTRUCTION	Brick and tile
HEIGHT, BUILDINGS	Two and three stories
HEIGHT OF STORIES	9 ft.
CONSULTING ENGINEER	Huldreich Egli
BOILERS	4—120 hp.
TYPE	Firebox, long combustion cham
STEAM PRESSURE	100 lb.
FUEL	2—Bunker C oil; 2—Penna. semi-bituminous coal
FUEL BURNING EQUIPMENT	2 stokers, 2 oil burners
HEATING SURFACE	40,000 sq. ft.
TYPE HEATING SYSTEM	Steam vacuum return

OTHER PROJECTS ARE:

BIRMINGHAM: "Smithfield Court"; $2,500,000; one- and two-story group houses and three-story apartments; 664 living units; 28 acres. Work proceeding.

CAMBRIDGE: $2,500,000; three-story apartments; 294 living units; 9 acres.

CHARLESTON: "Meeting St. Manor," "Cooper River Court"; $1,500,000; one- and two-story group houses; 272 living units; 16 acres.

CHICAGO: "Jane Addams Houses and Jane Addams Add'n"; $6,950,000; three-story apartments; two-story group houses; 981 living units; 24 acres. Work proceeding.

CHICAGO: $3,250,000; two-story group houses and flats; four-story apartments; 462 living units; 21 acres.

CINCINNATI: "Laurel Homes"; $6,500,000; three- and four-story apartments; 1,279 living units; 24 acres.

CLEVELAND: "Cedar-Central Apts."; $3,279,000; three-story apartments; 654 living units; 18 acres.

CLEVELAND: $3,650,000; three-story apartments; two-story flats and group houses; 579 living units; 21 acres.

COLUMBIA, S. C.: "Columbia Terrace"; $500,000; one- and two-story group houses; two- and three-story apartments; 142 living units; 4 acres.

DALLAS: "Lucas Drive"; $900,000; one- and two-story group houses; two-story apartments; 196 living units; 22 acres.

DETROIT: "Parkside"; $4,500,000; three-story apartments; two-story group houses and flats; 779 living units; 31 acres.

ENID, OKLA.: "Cherokee Terrace"; $435,100; one- and two-story group houses; 90 living units; 5 acres.

EVANSVILLE: "Lincoln Gardens"; $1,000,000; one- and two-story group houses and flats; 195 living units; 11 acres.

INDIANAPOLIS: "Lockefield Garden Apts."; $3,025,000; three-story apartments, two-story group houses; 748 living units; 22 acres.

JACKSONVILLE: "Durkeeville"; $1,000,000; one- and two-story group houses; 239 living units; 20 acres.

LEXINGTON, KY.: "Blue Grass Park," "Aspendale"; $1,500,000; one- and two-story group houses; two-story flats; 286 living units; 68 acres.

LOUISVILLE: "La Salle Place"; $1,200,000; one- and two-story group houses; 210 living units; 14 acres.

MEMPHIS: "Dixie Homes"; $3,200,000; one- and two-story group houses; two-story flats and gallery apartments; 743 living units; 42 acres.

MEMPHIS: "Lauderdale Courts"; $3,000,000; one- and two-story group houses, and three-story apartments; 469 living units; 26 acres. Work proceeding.

MIAMI: $1,000,000; one- and two-story group houses; 243 living units; 62 acres.

MINNEAPOLIS: "Sumner Field Homes"; $3,500,000; three-story apartments; group houses and flats; 613 living units; 32 acres.

MONTGOMERY, ALA.: "Riverside Heig $416,000; one- and two-story group ho 100 living units; 14 acres.

MONTGOMERY, ALA.: "Wm. B. Pat Courts"; $459,000; one- and two-story houses; 158 living units; 7 acres.

NASHVILLE: "Cheatham Place"; $1,70 one- and two-story group houses; 332 units; 22 acres.

NASHVILLE: "Andrew Jackson Co $1,500,000; one- and two-story group h and two-story flats; 383 living unit acres.

NEW YORK: "Ten Eyck Houses"; $1 000; four-story walk-up apartments; living units; 26 acres.

NEW YORK: "Harlem River Ho $4,700,000; four- and five-story w apartments; 574 living units; 9 acres.

OKLAHOMA CITY: $2,000,000; one two-story group houses; 389 living 37 acres.

OMAHA: $2,000,000; one- and tw group houses, two-story flats; 326 units; 20 acres.

SCHENECTADY: "Schonowee Vi $1,500,000; three-story apartments; story flats; 286 living units; 9 acres

TOLEDO: $2,000,000; three-story ments, two-story group houses and fla living units; 16 acres.

WAYNE, PA.: "Highland Homes"; $3 one- and two-story group houses, tw flats; 50 living units; 2 acres.

Automatic Controls for Summer and Winter Unit Conditioners

THERE is no simple way of distinguishing between central fan systems and the so-called unit fan systems except the rather unsatisfying ways which are in common use. Although everyone familiar with the equipment used for heating, ventilating, and air conditioning recognizes what is meant by the unit fan methods, the distinction now has but little descriptive meaning. Units are used every day in such ways that to all intents and purposes they are really central systems, for ducts are now commonly attached to them and they are located outside the space being treated about as often as they are located inside. The distinction is approaching one of describing where the assembly of parts takes place. Units are assembled at the factory to a great degree while the central plants, usually being used on larger installations, are in general erected on the site. Units must be compact, and installation must be easy. Noise problems are more acute than with central installations.

In the main, any processing of a mass of air can be equally well accomplished by the use of either unit fan equipment or a central fan system. Which method is to be used on a particular job depends on factors such as cost, and other conditions peculiar to the job itself.

So also is the problem of securing automatic operating control essentially the same in each case. In principle at least, the equipment available for securing this control is also similar regardless of whether the air processing is to be accomplished at one central conditioner or at one or several unit conditioners.

In view of this, it is correct in principle to state that any or all of the control methods and equipment which have been illustrated in previous articles for central fan systems can equally well be used in unit systems. In short, the problem and the solutions are similar regardless of the fan location or number. However, there are some differences, and a few examples of application of controls to units are illustrated—just enough to make some of the similarities and differences clear.

Kind of Unit Conditioners

It is well to outline the kinds of units available and those to be considered here.

The units intended for winter use only are what have come to be called unit heaters and unit ventilators. The unit heater is seldom connected to outside air, although it can be so connected. The unit ventilator, which has found so wide a use in school buildings, is usually connected to outside air and is a device for accomplishing both heating and ventilating. The unit heater seldom has a humidifying device or an air filter, while the unit ventilator frequently does have them.

Units for summer use only, generally are connected to outside air, except where human occupancy is sparse. The unit cooler is closely akin to the unit heater and is frequently not connected with the outside. Like the unit heater, it seldom has an air filter built in. Other summer units are so constructed that they include filters and are connected to the outside. Among these are units using surface coils and those using water sprays, or washers, for the cooling device. They may be attached to mechanical refrigerators, or to any available source of cold water. Sometimes the mechanical refrigeration equipment is built into the unit as in the "self-contained" style, or the source of cold may be "remote."

Year 'round units combine the features of the winter units with those of the summer units. There are thus really two separate devices included in the same casing. The problem of switch-over from the one device to the other is similar to that outlined in the preceding article and in general is solved in the same ways as in central fan plants.

All of these units, whether for summer or winter use or both, are available in shapes, sizes, styles, and finishes to correspond with their intended purposes. Any of them can be had for floor or ceiling mounting, for use exposed or concealed, or for location inside the conditioned space or outside of it.

The Diagrams

Since we are here concerned only with automatic controls as used on these units, it is obviously impossible to attempt to illustrate more than a few of these varieties of the unit conditioner. For the sake of uniformity of layout, all the diagrams illustrate a floor unit located inside the conditioned space. All are shown connected to outside air, and the outside dimensions of the units are kept uniform. So far as possible all the symbols used for dampers, motors, temperature and humidity controllers are exactly the same as in the preceding articles of this series in order that similarities may be easily noted. As heretofore, the diagrams are not to scale in any direction, nor do they illustrate actual equipment. Details of construction not essential to the present purpose are omitted from the sketches.

While the diagrams in this article have had to be made somewhat different in form from those in the previous parts of the series, their form has been kept as similar to those as possible. Consequently, the outlines do not represent any commercial outlines very closely.

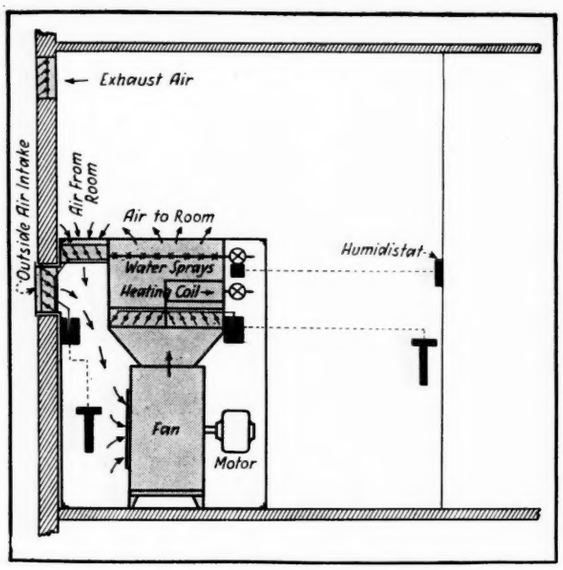


Fig. 1.

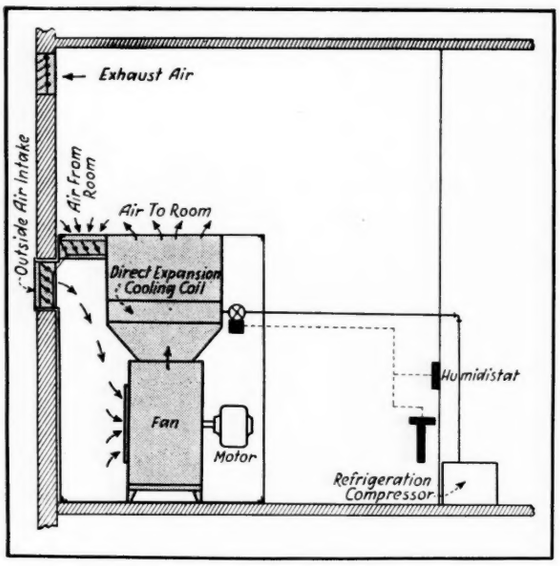


Fig. 2.

Operating Requirements

Unit fan systems are commonly required to operate steadily with the fan wheel in motion all the time. In other words, control achieved by starting and stopping the fan is not the usual method, although often practiced on unit heaters and coolers not connected to outside air and also on certain units used in house conditioning.

Winter units usually operate to maintain a steady dry bulb temperature in the room and humidification may or may not be under automatic control. Unit ventilators, as used in schoolrooms, often omit any humidification control, although such control can be readily added.

Summer units are expected to accomplish both cooling and dehumidification quite generally. Automatic controls for both the dry bulb temperature and relative humidity are common but by no means universally in use at present.

Year 'round units are expected to maintain one set of conditions in summer and another set in winter. Consequently, there must be a switch-over, and frequently a period when first one set of conditions governs and then the other. As in the case of central fan systems, this switch-over can be accomplished either manually or automatically. The units illustrated in the accompanying diagrams, however, show only automatic change-over. Also, only the method of switch-over which uses two separate sets of sensitive elements for summer and for winter is shown.

Automatic operating control of unit conditioners is just as important and just as necessary as with central fan equipment. There seems to have been a general tendency to skimp on controls in designing and applying unit conditioners, although there is no sound reason for such a situation. The real reason has probably been first cost and the commercial urge to promote the use of these units in markets where first cost of equipment has been thought to be a factor of such importance as to dwarf the effect of operating savings possible with automatic control.

Fig. 1 illustrates a unit equipped for use in winter only—the unit ventilator. As illustrated, the automatic controller at the left modulates the damper motor, which positions the compound damper to decrease the amount of inside air, as the amount of outside air increases, and thus to keep a steady temperature at the fan entrance. The controller at the right operates the face and bypass damper to keep the room temperature steady by bypassing more air as the room temperature rises. The valve on the heating coil is open all the time or is operated manually. The room humidity controller opens and closes the valve leading to the water sprays. On operating unit ventilators the controller at the left is often omitted and the compound damper is positioned manually.

Fig. 2 shows a unit cooler for summer use only but connected to outside air. On comfort installations the outside air damper can be set for a minimum opening depending on the number of people present and the remainder of the air supply can be taken from inside the space. The arrangement of a controller to keep the air temperature at the fan entrance steady, as shown in Fig. 1, can be used readily, if desired. On process applications especially, the unit is often not connected to outside air at all. The temperature and humidity controllers in the room air, and which may actually be one combined instrument, both operate the valve in the refrigerant line leading from the remotely located refrigeration compressor. The humidity controller acts as a limit instrument and cuts in to increase the room humidity even though the temperature controller may be satisfied.

The refrigeration compressor is shown remote but evidently could be located inside the metal casing of the unit if desired and thus make a "self-contained" summer unit, in which case the controller could be arranged to stop and start the compressor instead of positioning a valve in the refrigerant supply lines.

Evidently, too, the refrigeration compressor shown can be used to supply refrigerant to as many units as its cooling capacity will permit. Such an installation

may be controlled by using one room temperature (and humidity) controller for each unit, or one room controller may be used and so arranged that one unit after another will cut in as the room temperature rises. Obviously, too, the compressor could be used to cool a supply of water and this cooled water could be sent to each unit with a valve at the entrance to the cooling coil under command of a controller as shown in the diagram.

Figs. 3 and 4 both show year 'round conditioning units. In Fig. 3 the refrigeration compressor is remote, while in Fig. 4 the compressor is located inside the cabinet. In Fig. 3 the summer room controls position a valve in the line leading to the cooling coil but in Fig. 4 they start and stop the refrigeration compressor. This method of summer control could equally well be used if the compressor were remotely located as in Fig. 2. In Fig. 3 a surface cooling coil is shown and any source of cold can be used as can also the plan of mixing cold and warm water from any available source in order to secure a fixed temperature in the cooling coil, if desired.

Operation of the unit shown in Fig. 3 is as follows. Throughout the year the controller shown at the fan intake operates to keep a steady temperature in the air entering the heating or cooling coil. The instrument may be so set that in winter it really positions the compound dampers while in summer it holds the outside damper at a fixed minimum opening and holds the return damper nearly wide open.

During winter operation the temperature controller (W) modulates the valve to admit more or less steam to the heating coil, as required to keep the room temperature steady while the humidity controller (WH) opens and closes the valve leading to the water sprays to keep the humidity within limits.

In summer operation the temperature controller (S) modulates the valve leading to the cooling coil to admit more or less cold water or refrigerant to keep the room temperature steady. The humidity controller (SH) acts as a limit control.

Switch-over from summer to winter operation is automatic if the two temperature controllers are properly set. Controller (W) is set at, say, 70 F while controller (S) is set at, say, 75 F. Then as the temperature rises toward 75 F, it indicates that a change toward cooling is taking place and the cooling controls take command. On a fall toward 70 F, the opposite change is indicated and the heating controls take command.

It is also worth noting that Fig. 3 really is made up by adding the arrangement of Fig. 2 directly to the arrangement shown in Fig. 1. It thus illustrates how the year 'round unit and the year 'round controls can be considered as two separate plants, if desired. It should also be noted that the arrangement shown is almost exactly the same as the one shown in a previous article for a central fan system. (See Fig. 2, page 48, HEATING & VENTILATING, May, 1936.—Editor.)

In the diagrams the only switch-over method shown for changing between summer and winter operation is that which uses two sets of controls and in which the control is from the room conditions. Switch-over can

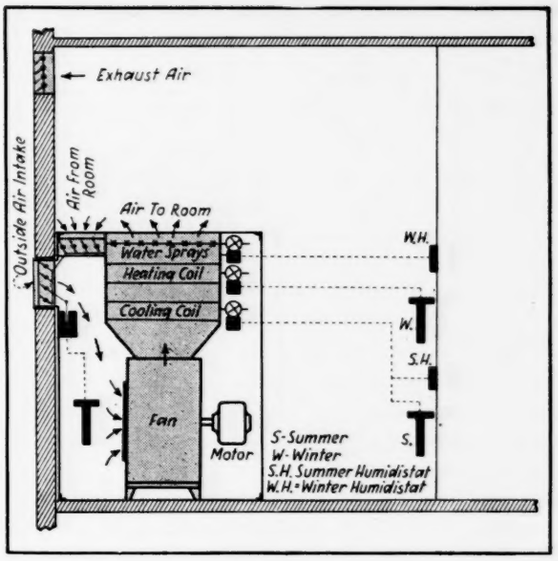


Fig. 3.

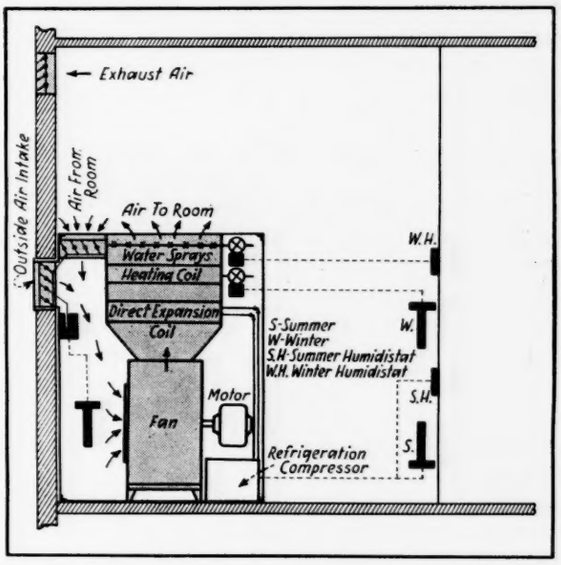


Fig. 4.

also be secured automatically by using a single set of room controls and a pilot thermostat to sense outside or inside conditions and to furnish the impulse necessary to accomplish the change-over. So, too, can any of the methods illustrated and discussed on pages 48 to 50 of the May, 1936, issue of HEATING & VENTILATING.

Because the diagrams do not show any conditioning units using a washer for cooling and humidifying instead of a surface coil and intermittent water sprays, it should not be concluded that conditioning units do not make use of this equipment. Units using a washer are frequently used both for comfort work and for industrial process. When washers are used the dew-point method of control with means for controlling the temperature of the spray water is popular, but the reader is referred to the descriptions and diagrams showing some of these control arrangements which appeared on page 49 of the May, 1936, issue of HEATING & VENTILATING.

GETTING DOWN TO FUNDAMENTALS

13—Estimating Heat Quantities Due to Humidity Changes

CHANGES in humidity, or moisture content of the air, go on more or less continuously in heating, ventilating, and air conditioning plants. While all such changes are of some importance, not all of them are of any particular importance in the preparation of estimates for determining the capacity of heating or cooling plants. For this purpose only those changes which occur when the plant is operating at peak load need be considered in any detail. In this article attention is confined largely to the fundamentals of estimating the heat quantities arising from those changes in humidity which occur on the coldest winter days and on summer days when the plant is likely to experience its greatest demand.

Why Is There a Heat Quantity?

Before proceeding to methods of estimating, however, it is well to get in mind the fundamental reason why there is a heat quantity involved when humidity changes.

Humidity, moisture, and water vapor in the air are all essentially only different terms for designating the same quantity. Water vapor is simply another term for steam at low pressure. In other words "humidity" means "steam," for in the air with which we commonly deal moisture exists in the form of a vapor and not in the form of a liquid. If this is true, then instead of referring to "humidity changes" we could just as well call those changes "steam changes" or "changes in the amount of steam in the air" in practically all the cases with which we are here concerned. Probably clear thinking would be aided and humidity would be more understandable if this term were adopted.

There are just two directions in which the amount of steam in the air can be changed. Either the change must result in an *increase* in the amount or else it must result in a *decrease*. Here we run into more language complexities. When the change results in an increase in the amount of steam in the air, it is said that "humidification" has taken place. If the change results in a decrease it is said that there has been "dehumidification."

Consider now what really happens when we increase the amount of steam in the air. The only way the amount can be increased is to cause water, a liquid, to turn into steam, a vapor, and to cause this vapor to mix with air, a gas. Somewhere in the process (and this is an important fact) liquid water has been changed into a vapor. In other words it has been "evaporated," as we say, or "vaporized," or more plainly still it has been "boiled." Now it is well known in the experience of everyone that to boil water requires the addition of a quantity of heat somewhere or other in the process.

In the same way when we decrease the amount of steam in air we cause steam, a vapor, to change back into liquid water and to leave the air with which it has been mixed. In other words, the steam has been "condensed," as we say, or "liquefied." It is equally well known as a matter of experience that whenever steam condenses into water, a quantity of heat is liberated.

Thus, regardless of the direction of the change there is always a quantity of heat involved whenever the humidity changes. The heat necessary for effecting humidification may come from a variety of sources and that released by dehumidification may go to a variety of destinations. The practical problem is to determine how and when these sources and destinations affect the peak capacity of the plant, if at all, and if so to estimate the amount.

All this can be summed up in the following fundamental statements:

1.—*Every* change in humidity involves a heat quantity.

2.—An increase in humidity, often called *humidification,* is really a process of *boiling or evaporating* liquid water into a vapor, and *heat is added.*

3.—A decrease in humidity, often called *dehumidification,* is really a process of *condensing* steam into water, and *heat is liberated.*

4.—The heat quantities may or may not be important in estimating peak capacities depending on their sources and destinations which must be found, examined, and evaluated.

Sources of Humidity Changes

In finding and examining the sources and destination of the heat quantities it is helpful to recall that in practice there is commonly a desire to maintain a set humidity of the air inside a building. It is not necessary to discuss just why it is desired to do this, but among the considerations may be comfort or the desire to process materials. Keeping this humidity steady can be accomplished only if all attempts to vary it are successfully resisted. Now we may inquire into the sources of the moisture which may try to cause the maintained humidity to change. These are:

1.—Moisture in air brought in from the outside; if done deliberately this is ventilation air; while if involuntary it is filtration air.

2.—Moisture given up by humans.

3.—Moisture from incidental boiling of water as in food preparation, bathing, washing, or in many processes such as dyeing, bleaching, leeching, etc.

4.—Moisture passing through walls.

5.—Moisture given up or absorbed by materials stored or resting in or passing into and out of, the building, including furnishings or furniture.

Of these, the first is almost universally operative, and important in amount, for virtually no buildings are completely air tight. However, the importance varies greatly with the period of the year and other factors.

So, too, the second is very commonly met with, for humans are present in most buildings, but its importance changes greatly from time to time.

Moisture from the sources listed in three is frequently encountered especially in the cases of food preparation and washing operations.

Little is known about the fourth, for while almost no building materials are impervious to moisture the mechanism of travel of this moisture is not clear nor is the amount stable or subject to convenient estimates. As a result it is usually dismissed from consideration.

The fifth is encountered most frequently in connection with the artificial moistening or drying of specific moisture-sensitive materials. In such instances it is essential that the whole nature of the process and its timing be considered. The quantities of the materials, their initial and final moisture contents, and their properties for absorbing or giving up moisture to air must be known. Furnishings or furniture are a special case for they usually remain in the building more or less permanently instead of merely passing through as do the majority of process goods.

Effect of Moisture Sources on Peak Loads

Now recall that we are here concerned not so much with humidity changes in general as with those which affect the summer or winter peaks. There is no generalized rule by which these effects can be determined in advance in all cases for each case must be examined individually. However, there are some points which occur with enough uniformity to justify their discussion.

Heat quantities which arise from the introduction of outside air in winter nearly always consist of adding heat to this air and steam mixture because the inside humidity is greater than that outside. This heat would go to increase the peak capacity if the necessity for much humidification existed at the time of the winter peak load. As a matter of fact this is seldom if ever the case because at extremely low outside temperatures only a small amount of humidity can be added to the outside air without causing condensation on windows. The greatest heat quantity due to this humidity change therefore usually occurs off-peak when there is plenty of plant capacity to take care of it. Consequently, there is seldom if ever any necessity for calculating the amount of heat due to this humidity change when preparing estimates of winter peak loads.

The opposite is true in summer, however. The time when greatest dehumidification is required is fairly likely to occur during the peak period, or even to cause the peak. Consequently, careful attention must be given to the heat quantity in estimating summer peak loads.

Heat quantities due to humidity changes caused by humans are peculiar in that regardless of the season of the year the human gives off moisture to the air. The amount given off, however, varies greatly with the surroundings, with the rate at which he works, and with a variety of other factors. In estimates of both summer and winter peak the effect of the moisture passing into air from the bodies of humans has to be examined carefully. More often than not it will be found to be occurring on peak. In such cases it is necessary to estimate its amount and to include it in sizing equipment.

When there is boiling of water, or where there are open tanks or vats of hot water, or where food is cooked or prepared, or where open gas flames burn without a vent for carrying off the combustion products, there are likely to be humidity changes and, consequently, heat quantities. However, it is necessary to study each of these cases with some care. In winter when humidification is being practiced an increase in humidity due to these operations, if the heat source is independent of the heating plant, does not add to the capacity necessary in that plant. Thus, a separately-fired gas coffee urn would not add to the heating plant capacity and might even help it. If a steam table were kept warm by steam supplied by the heating plant this table *might* add to the capacity necessary at peak and the case should be examined closely if the table uses any appreciable amount of steam.

In summer, however, any moisture which the air absorbs from any of the processes or devices just mentioned will be found to be almost certain to add to the load. If they occur at peak they must be estimated and allowed for.

It will thus be seen that in general humidity changes are not especially likely to affect the winter peak loads although the possibilities in each case should be given attention. In summer, however, the heat liberated from the outside air when it is brought into the building and also that which results in moisture being evaporated inside the building may *all* not only go to add to the load but may occur at peak periods. From this it follows that all humidity changes in summer should be considered, and their effect on the peak load examined.

Calculating Methods

Suppose that as a result of a suitable examination it is found that certain of the humidity changes just discussed are of importance in affecting the peak load and must be calculated, the question arises of how to go about making the calculations. Let us now turn attention to this question.

Fundamentally, there is really only one method of calculating the heat quantity. What is wanted is the quantity of heat which is involved when some weight of water is boiled into steam or when this same weight is condensed back into water. The process consists of finding the weight of water boiled, or of steam condensed, in some suitable unit such as pounds. Multiplying this weight by the heat quantity in B.t.u. which is required or liberated per pound, gives the amount of heat. The heat quantity in B.t.u. per pound depends on the pressure and has been repeatedly measured and tabulated in steam tables as the Latent Heat of Vaporization.

Therefore, to use this method of calculation it is necessary only to know the weight in pounds of the steam evaporated or condensed and to have a set of steam tables. In the absence of a set of steam tables a common short cut is to assume that the latent heat of vaporization is 1,000 B.t.u. per lb. This short cut gives approximate results.

It should be noted that to use this method it is necessary to know, or to be able to determine by direct measurement or otherwise, the weight of the water boiled or the steam condensed. In many cases this weight can be found by measurement as in the boiling of water on an open flame the weight of the water boiled can be found with any pair of weighing scales. So also losses of weight in tanks or vats can be found, or the amount of steam condensed can be found by catching it in a pan and weighing it. When the weights can be thus determined this method of calculation is simple and fundamental. There is nothing to go wrong, no complicated or confusing charts or tables. The heat quantity thus found is all latent heat. This method of calculation is to be recommended wherever it is possible to get direct information concerning weights.

There are cases, however, where the weight of water evaporated cannot be directly determined and also where the effect on the air of the heat added or liberated is desired. In such cases it is convenient to devise other methods of calculation. One situation in which such a method is especially convenient is when a mixture of steam and air from outside is brought into a building maintained at a humidity different from that outside. This is so common an occurrence that the method is described in some detail.

This method is really only a modification of the one just outlined. In it the information on heat quantities at various dry bulb temperatures is tabulated. A suitable formula and proper use of such a table is a great convenience in solving a variety of humidity problems. Table 1 presented here has been calculated and arranged to permit using this method.

It will be noted that Table 1 is really a combination of three separate tables.

The one at the left gives the properties of saturated steam at low pressure. From the data given all the usual properties of low pressure steam may be read or derived, except entropy which does not enter into problems of this kind.

The middle table gives the properties of dry air at atmospheric pressure and considered as a perfect gas. From this table any of the properties of dry air can be read or derived.

The table at the right gives important properties of a mixture of dry air and saturated steam. Such a mixture is commonly called "saturated air." It could equally well be called "air at 100% relative humidity." As a matter of fact it is the only air and steam mixture which contains saturated steam, for such mixtures at any relative humidity except 100% contains only superheated steam and no saturated steam. Also such a mixture of dry air and saturated steam contains the greatest weight of moisture which can be mixed with a given weight of dry air at any particular temperature. These various explanations of the meaning of the table help in fixing firmly in mind just what kind of a steam and air mixture is included in the table.

Note also that columns 1 and 16 are the same. This is true because by definition the wet and dry bulb temperatures coincide when a steam and air mixture is "saturated" or when saturated air is under consideration. From this it follows that at any relative humidity except 100% the dry bulb and wet bulb temperatures are not alike; the wet bulb is always less than the dry bulb reading.

Particular attention is directed to columns 14 and 15. These give the amount of latent heat and total heat, respectively, in a mixture of steam and air when saturated. Note carefully that the heat in column 15 includes that in column 14. These two columns give the amount of heat at the wet bulb temperature of column 16. Now recall also that for any wet bulb temperature the amount of heat is nearly steady regardless of the relative humidity. This fact permits the table to be used without serious error for finding the amount of heat involved in humidity changes.

The procedure is first to determine from known conditions the wet bulb temperature at the initial condition, then to find the wet bulb temperature at the final condition. With the two wet bulb temperatures known the heat quantities are read from the table. Subtracting gives the heat quantity per unit weight of air. This procedure can be simply expressed by the following equation in such a form that it applies directly to the table.

$$H_h = W(h_1 - h_2) \qquad (6)$$

when

H_h = Quantity of heat involved in a change of humidity between an initial wet bulb (t_1) and a final wet bulb (t_2), in B.t.u. per hr.

h_1 = Total Heat (column 15 of Table 1) at the initial wet bulb temperature (column 16 of Table 1).

h_2 = Column 15 of Table 1 at the final wet bulb temperature of column 16.

W = Lb. of dry air per hr.

Example: What quantity of heat is involved when 200 lb. of dry air per hour are cooled from a wet bulb temperature of 78 F to a wet bulb temperature of 64 F?

Here $t_1 = 78°$ and $t_2 = 64°$. Simply look in column 15 of Table 1 opposite 78 F and read 41.33 B.t.u. as the total heat, or h_1; also opposite 64 F find 29.25 B.t.u., as h_2. Substitute in equation (6) and get:

$$H_h = 200(41.33-29.25) = 200(12.08) = 2416 \text{ B.t.u. per hr.}$$

Since the process results in less moisture in the final condition than in the initial condition this amount of heat is liberated. If its liberation from 200 lb. of air which originally contained it occurs at a time of peak load and if this heat goes to add to the load, then it must be considered in estimating the peak requirements.

The example just outlined is stated in its simplest form because the wet bulb temperatures were given. The problem of the heat quantity due to humidity from air brought in from the outside usually occurs in terms of outside dry bulb and relative humidity and an inside dry bulb and relative humidity. In such cases equation (6) is still used but some preliminary operations are necessary to determine the wet bulb temperatures. Such a problem is illustrated in the following example.

Example: What quantity of heat is involved when

200 lb. of dry air from outside at a dry bulb temperature of 95 F and a relative humidity of 50% are brought into a building and cooled to 85 F and 45% relative humidity?

In Table 1 locate 95 F in column 1 and move horizontally to column 9, where 22.80 is read as the B.t.u. in each pound of dry air. Then move to column 14 opposite 95 F and note that if the outside air were saturated at 95 F it would contain 37.96 B.t.u. of latent heat. As it is only 50% saturated, multiply 37.96 by 0.50 and get 18.98 as the B.t.u. in the latent form at 50% relative humidity. The total heat per pound of

TABLE 1

DRY BULB TEMP., F	SATURATED WATER VAPOR (Steam)				DRY AIR (at 29.92 Inches of Mercury)				AIR SATURATED WITH WATER VAPOR (Mixture at Pressure of 29.92 Inches of Mercury)						Wet Bulb Temp., F
	Pressure	Weight		Heat	Weight	Volume		Heat	Volume	Weight		Heat			
	Inches of Mercury	Grains, per cu. ft. of Vapor	Grains, per lb. of Dry Air at 29.92" Hg.	Total Heat, B.t.u. per lb. of Vapor	Pounds, per cu. ft.	Cu. ft., per Pound	Per cent, of Volume at 70 F	B.t.u. per lb. (from 0 F)	cu. ft. in 1 lb. of dry air with vapor to saturate it	Grains, of dry air in 1 cu. ft. of saturated mixture	Grains, in 1 cu. ft. of saturated mixture	B.t.u., in 1 lb. of dry air and enough water vapor to saturate it			
												to raise temp. 1 F	Latent Heat	Total Heat	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
— 20	0.0126	0.166	1.837	1050	0.08945	11.08	0.837	— 4.8	11.08	631.7	631.92	0.278	0.26	— 4.62	— 20
— 15	0.0168	0.217	2.437	1052	0.08842	11.20	0.849	— 3.6	11.208	624.5	624.69	0.264	0.35	— 3.23	— 15
— 10	0.0220	0.284	3.222	1055	0.08741	11.33	0.859	— 2.4	11.34	617.3	617.54	0.270	0.48	— 1.91	— 10
— 5	0.0290	0.368	4.228	1057	0.08651	11.45	0.865	— 1.2	11.46	610.8	611.19	0.277	0.614	— 0.56	— 5
0	0.0377	0.474	5.49	1059	0.08636	11.58	0.868	0.0	11.59	604.0	604.47	0.291	0.805	0.824	0
5	0.0489	0.607	7.12	1062	0.08540	11.71	0.879	1.20	11.72	597.2	597.8	0.302	1.05	2.28	5
10	0.0630	0.775	9.19	1064	0.08446	11.84	0.887	2.40	11.86	590.2	591.0	0.322	1.37	3.79	10
15	0.0807	0.983	11.78	1066	0.08354	11.97	0.896	3.60	11.98	584.3	585.3	0.340	1.80	5.4	15
20	0.1028	1.24	14.98	1068	0.08271	12.09	0.905	4.80	12.12	577.6	578.8	0.364	2.26	7.09	20
25	0.1304	1.55	19.01	1070	0.08183	12.22	0.916	6.00	12.24	571.9	573.5	0.396	2.87	8.91	25
30	0.1645	1.940	24.07	1073	0.08097	12.35	0.925	7.20	12.41	564.1	566.0	0.41	3.696	10.89	30
32	0.1802	2.12	26.39	1074	0.08065	12.40	0.930	7.68	12.46	561.8	563.9	0.43	4.05	11.72	32
35	0.2036	2.38	29.80	1075	0.08019	12.47	0.934	8.40	12.54	558.2	560.6	0.44	4.43	13.00	35
40	0.2478	2.87	36.40	1077	0.07937	12.60	0.944	9.60	12.70	551	553.8	0.47	5.56	15.21	40
45	0.3003	3.44	44.10	1079	0.07862	12.72	0.954	10.80	12.82	547	550.4	0.544	6.71	17.37	45
50	0.3624	4.11	53.50	1082	0.07782	12.85	0.963	12.00	13.01	538	542.1	0.574	8.13	20.29	50
55	0.4358	4.89	64.30	1084	0.07710	12.97	0.972	13.20	13.16	533	537.9	0.63	9.76	23.16	55
60	0.5214	5.77	76.95	1086	0.07634	13.10	0.981	14.40	13.34	525	530.8	0.70	11.63	26.31	60
62	0.5600	6.20	83.00	1087	0.07605	13.15	0.985	14.88	13.40	524	530.2	0.756	12.48	27.72	62
64	0.6004	6.53	89.10	1088	0.07576	13.20	0.989	15.36	13.48	520	526.5	0.75	13.44	29.25	64
65	0.6218	6.85	92.50	1089	0.07559	13.23	0.992	15.60	13.51	519	525.8	0.70	13.94	30.0	65
66	0.6438	7.05	95.46	1089	0.07547	13.25	0.993	15.84	13.54	517	524.0	0.80	14.55	30.7	66
67	0.6664	7.31	99.20	1090	0.07530	13.28	0.994	16.08	13.58	516	523.3	0.82	14.97	31.5	67
68	0.6898	7.57	102.50	1090	0.07519	13.30	0.997	16.32	13.60	515	522.6	0.84	15.44	32.32	68
69	0.7140	7.80	106.5	1090	0.07502	13.33	0.998	16.56	13.65	514	521.8	0.84	16.03	33.16	69
70	0.7387	8.06	110.2	1091	0.07491	13.35	1.000	16.80	13.69	512	520.0	0.86	16.60	34.00	70
71	0.7643	8.33	114.1	1091	0.07474	13.38	1.002	17.04	13.72	511	519.3	0.87	17.14	34.86	71
72	0.7906	8.59	118.1	1092	0.07463	13.40	1.003	17.28	13.77	509	517.6	0.92	17.74	35.71	72
73	0.8177	8.88	122.5	1092	0.07446	13.43	1.006	17.52	13.80	508	516.9	0.91	18.43	36.63	73
74	0.8450	9.16	126.8	1092	0.07435	13.45	1.008	17.76	13.84	506	515.2	0.92	19.00	37.54	74
75	0.8745	9.46	130.5	1093	0.07418	13.48	1.010	18.00	13.88	505	514.5	0.93	19.57	38.46	75
76	0.9040	9.76	135.4	1093	0.07402	13.51	1.012	18.24	13.91	504	513.8	0.94	20.30	39.39	76
78	0.9660	10.39	145.1	1094	0.07375	13.56	1.015	18.72	13.98	502	512.4	1.12	21.73	41.33	78
80	1.0320	11.05	156.0	1095	0.07348	13.61	1.020	19.20	14.07	499	510.0	1.12	23.31	43.58	80
85	1.2135	12.88	183.5	1098	0.07283	13.73	1.028	20.40	14.30	490	502.9	1.30	27.56	49.20	85
90	1.4210	14.95	217.2	1100	0.07215	13.86	1.038	21.60	14.55	482	496.9	1.50	32.36	55.70	90
95	1.6600	17.30	255.8	1102	0.07153	13.98	1.047	22.80	14.81	474	491.3	1.66	37.96	63.20	95
100	1.9320	19.96	300.5	1104	0.07087	14.11	1.059	24.00	15.06	465	485.0	1.86	44.00	71.50	100
105	2.2414	22.97	352.0	1106	0.07022	14.24	1.066	25.20	15.39	455	478.0	2.24	52.0	80.8	105
110	2.5940	26.37	413.0	1109	0.06964	14.36	1.074	26.40	15.71	446	472.4	2.44	60.9	92.0	110
115	2.9930	30.17	483.0	1111	0.06901	14.49	1.084	27.60	16.20	433	463.2	2.88	70.9	104.4	115
120	3.4450	34.40	566.0	1113	0.06845	14.61	1.095	28.80	16.50	426	460.4	3.34	83.0	118.8	120
125	3.9520	39.15	662.0	1115	0.06784	14.74	1.102	30.00	16.98	413	452.1	3.94	96.9	135.5	125
130	4.5220	44.30	775.0	1118	0.06729	14.86	1.113	31.20	17.50	401	445.3	4.6	113.0	155.2	130
135	5.1630	50.31	910.0	1120	0.06671	14.99	1.122	32.40	18.13	386	436.3	5.38	132.7	178.2	135
140	5.8780	56.85	1063.0	1122	0.06614	15.12	1.132	33.60	18.81	373	429.8	6.14	153.9	205.1	140
145	6.6780	64.10	1249.0	1125	0.06562	15.24	1.141	34.80	19.74	356	420.1	7.64	184.6	235.8	145
150	7.5660	72.00	1478.0	1127	0.06506	15.37	1.150	36.00	20.58	341	413.0	8.70	213.0	274.0	150
155	8.5530	80.80	1741.0	1129	0.06452	15.50	1.161	37.20	21.70	324	404.8	11.28	250.2	317.5	155
160	9.6490	90.50	2070	1131	0.06402	15.62	1.170	38.40	23.02	304	394.5	13.54	296.6	373.9	160
165	10.860	100.4	2480	1134	0.06349	15.75	1.180	39.60	24.70	284	384.4	16.70	354.6	441.6	165
170	12.200	108.4	2990	1136	0.06301	15.87	1.188	40.80	26.73	262	370.4	25.81	426.0	525.1	170
180	15.290	134.0	4540	1140	0.06200	16.13	1.209	43.20	33.95	207	341.0	50.24	643.4	783.2	180
190	19.00	169.0	7580	1145	0.06105	16.38	1.225	45.60	44.70	157	326.0	135.7	1068.9	1285.6	190
200	23.46	209.0	15,820	1149	0.06013	16.63	1.245	48.00	75.60	92.6	301.6	—	2217.1	2643.0	200

Vapor Pressures based on International Critical Tables. Total Heats based on Keenan Steam Tables.

Specific Heat of air at constant pressure = 0.24 B.t.u.; 1 lb. avoirdupois = 7000 grains.

Column 14 does not include heat of liquid; Column 15 does include heat of liquid.

outside air in the mixture is 22.80 plus 18.98 or 41.78 B.t.u. This is h_1 in equation (6). In column 15 note that at 78 F wet bulb the total heat is 41.33 while at 80 F it is 43.58. Therefore, the wet bulb temperature of the outside air is slightly greater than 78 F and less than 80 F. Interpolation shows that the outside wet bulb is 78.4 F.

Proceed exactly the same way in Table 1 for the inside air. Opposite 85 F in column 1, read 20.40 in column 9, then in column 14 read 27.56. Multiply 27.56 x 0.45 and get 12.40. Then 20.40 plus 12.40 = 32.80 B.t.u. This is h_2 in equation (6). Similarly, looking in column 16 it will be found that the wet bulb temperature of the inside air must be between 68 F and 69 F. Interpolation locates it at 68.5 F.

Substituting in equation (6) we get:

$$H_h = 200(41.78 - 32.80) = 200(8.98) = 1796 \text{ B.t.u. per hr.}$$

Sometimes, too, especially where humidity is decreased, it is desirable to be able to determine how much of the heat quantity involved is in the form of latent heat and how much is sensible heat. This can also be determined from Table 1. Column 14 can be used to advantage in this connection. In the example just given the latent heat in the outside air was 18.98 and that in the inside air was 12.40. The difference is 18.98 minus 12.40, or 6.58 B.t.u. Multiply this by 200 and we get 1,316 B.t.u. per hr. as the amount of latent heat involved. The amount of sensible heat is therefore 1,796 minus 1,316, or 480 B.t.u. per hr.

In using this method there is one point to be especially observed. When filtration heat and heat due to ventilation air are computed by the method outlined in previous articles in this series, the sensible heat is calculated. Therefore, that part of the heat quantity in column 15 of the table is already allowed for. In such cases not all the heat found by equation (6) should be added to the load but only the latent heat as found in the example just given. This is a point which does not seem to be well understood. To add the entire amount would be to introduce a serious error into the estimate.

Smoke Abatement and Insulation Studied by Institute

THE 23rd annual report of the director of Mellon Institute of Industrial Research, Dr. E. R. Weidlein, was recently submitted to the trustees. Doctor Weidlein's report summarizes the work being done at the Institute among which are several projects of concern to heating and ventilating engineers. According to the report, because of the importance of air conditioning in manufacturing plants as well as in hotels, restaurants, theaters, and private residences, the multiple fellowship of the Philip Carey Company, whose incumbents are R. H. Heilman and R. W. Ortmiller, has been conducting a thorough investigation of various insulating materials used in the low-temperature field. Most of the published data on conductivities of low-temperature materials relate to but one temperature; and as the conductivity of many low-temperature insulations varies considerably with temperature, it is essential that the conductivity be determined over the range of temperatures to which the material is to be applied. The results of this research indicate that the conductivity of some low-temperature insulations is increased by more than 50% for an increase in temperature of only 100 F. This fact is of high value to the industries and also to home owners who are contemplating residential insulating.

Work is also being carried on by the Institute in connection with the study of air conditioning in cities.

The Owens automatic filter, which collects samples of solids suspended in the atmosphere, has been in steady operation at the station of the fellowship, whose incumbent is H. B. Meller. Attempts to correlate the results, and those obtained with the Owens jet dust counter and the Hill dust counter, with meteorologic data have been carried on. Comparisons are being made between various types of photoelectric cells for use with a special spectrograph in measuring energy from natural light in the visible, the long ultraviolet, and the short ultraviolet regions. Investigation of the possibilities of simplification of physical methods for determining the character and amount of suspended solids in the atmosphere has progressed. In connection with the study of pneumoconiosis in the Pittsburgh district, use has been made of the spectrograph and the X-ray—the spectrograph to determine the elements in the ashed specimens of lungs and the X-ray to show the combinations in which these elements occur. These exploratory tools will be helpful in the further study of silicosis under the auspices of Air Hygiene Foundation of America, Inc. Tars from the combustion of bituminous coal are being investigated to determine whether they contain carcinogens in sufficient concentration to be of consequence in a smoky area. The tars used were taken directly from smokepipes.

In cooperation with the smoke abatement fellowship there has been preliminary research, using experimental animals, to determine the effects of mixtures of air with flue gases and accompanying solids. While no definite conclusions have been reached, there is evidence of the harmfulness of some of the air-diluted products of combustion of certain fuels, and a more scopeful investigation is being planned. The concentration of benzene in flue gases and in atmospheric air is now being determined.

HEAT TRANSMISSION TABLES

(Values of Coefficient U)

CONSTRUCTION NO.	INTERIOR MATERIALS → ← EXTERIOR MATERIALS	THICKNESS, INCHES	A	B	C	D	E	F	G	H	I
			FURRING STRIPS USED								
			Plain Wall, no Plaster	½" Plaster direct on Walls, no Furring	½" Plaster on Wood Lath on ¾" x 2" Furring Strips Spaced 16" O.C.	¾" Insulating Plaster on Metal Lath	½" Plaster on ½" Rigid Insulation	½" Plaster on 1" Rigid Insulation	½" Plaster on 2" Furring & ½" Rock Wool Fill	½" Plaster on ½" Flexible Insulation	½" Plaster on ½" Corkboard set in ½" Cement Mortar
1	Common Brick Throughout	4	0.43	0.47	0.33	0.35	0.24	0.18	0.13	0.21	0.15
2		8	0.23	0.33	0.26	0.26	0.20	0.16	0.12	0.18	0.14
3		12	0.16	0.31	0.23	0.23	0.18	0.15	0.11	0.16	0.13
4	4" Face Brick, remainder Common Brick	8	0.41	0.45	0.32	0.34	0.24	0.18	0.13	0.21	0.15
5		12	0.25	0.34	0.24	0.25	0.19	0.15	0.11	0.17	0.13
6		16	0.18	0.31	0.23	0.23	0.18	0.14	0.11	0.16	0.12
7		20	0.14	0.30	0.22	0.22	0.17	0.14	0.10	0.15	0.12
8		24	0.11	0.29	0.21	0.21	0.17	0.13	0.10	0.15	0.12
9	Limestone or Sandstone	8	0.66	0.62	0.35	0.37	0.25	0.18	0.13	0.21	0.15
10		12	0.56	0.51	0.31	0.33	0.23	0.17	0.12	0.20	0.14
11		16	0.47	0.44	0.28	0.30	0.21	0.16	0.12	0.19	0.14
12		20	0.41	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
13		24	0.36	0.34	0.24	0.26	0.19	0.15	0.11	0.17	0.13
14	Concrete	8	0.66	0.62	0.35	0.37	0.25	0.19	0.13	0.21	0.15
15		10	0.62	0.56	0.33	0.35	0.24	0.18	0.12	0.20	0.15
16		16	0.47	0.44	0.28	0.30	0.21	0.16	0.12	0.19	0.14
17		20	0.41	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
18	Hollow Clay Tile With 1" Stucco Exterior Finish	4	0.53	0.49	0.30	0.32	0.23	0.17	0.12	0.19	0.14
19		8	0.38	0.37	0.25	0.26	0.20	0.15	0.11	0.17	0.13
20		10	0.35	0.33	0.23	0.24	0.18	0.14	0.11	0.16	0.12
21		12	0.31	0.29	0.21	0.22	0.17	0.13	0.10	0.15	0.12
22	Hollow Gypsum Tile, Stucco 1st Fin.	16	0.24	0.23	0.18	0.19	0.15	0.12	0.08	0.14	0.11
23	Cinder Blocks With one Air Cell Across Heat Flow	4	0.55	0.51	0.32	0.33	0.23	0.18	0.14	0.10	0.16
24		8	0.42	0.39	0.26	0.27	0.20	0.16	0.11	0.18	0.13
25		12	0.36	0.34	0.24	0.25	0.19	0.15	0.11	0.17	0.13
26	Cement Blocks with one Air Cell Across Heat Flow	8	0.56	0.52	0.31	0.33	0.23	0.17	0.12	0.20	0.14
27		12	0.49	0.46	0.29	0.30	0.22	0.16	0.12	0.19	0.14
28	4" Brick or 4" Cut Stone with Hollow Clay Tile Backing of This Thickness	6	0.37	0.35	0.24	0.25	0.19	0.16	0.11	0.17	0.13
29		8	0.36	0.34	0.24	0.25	0.19	0.15	0.11	0.17	0.13
30		10	0.32	0.31	0.22	0.23	0.18	0.14	0.10	0.16	0.12
31		12	0.28	0.26	0.20	0.20	0.16	0.13	0.10	0.15	0.11
32	4" Brick or 4" Cut Stone with Concrete Backing of This Thickness	6	0.61	0.56	0.33	0.35	0.24	0.18	0.13	0.20	0.15
33		10	0.51	0.47	0.30	0.31	0.22	0.17	0.12	0.19	0.14
34		16	0.41	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
35	4" Brick Veneer With Cinder Block Backing of This Thickness	8	0.35	0.33	0.24	0.24	0.19	0.14	0.11	0.16	0.12
36		12	0.31	0.30	0.22	0.22	0.17	0.14	0.10	0.16	0.12
37	4" Brick Veneer With Cement Block Backing of This Thickness	8	0.45	0.42	0.27	0.29	0.21	0.16	0.12	0.18	0.13
38		12	0.40	0.38	0.26	0.27	0.20	0.15	0.11	0.17	0.13
39	4" Cut Stone with Common Brick Backing of This Thickness	8	0.37	0.35	0.24	0.25	0.19	0.15	0.11	0.17	0.13
40		12	0.28	0.27	0.20	0.21	0.16	0.13	0.10	0.15	0.12
		16	0.23	0.22	0.17	0.18	0.15	0.12	0.09	0.13	0.11

WOOD FRAME WALLS

Construction No.	Exterior Material	Interior Materials	A	B	C	D	E	F	G	H
			Type Sheathing ½" Plaster Direct on Sheathing	½" Plaster on Wood Lath on Studding	½" Plaster on ½" Rigid Insulation on Sheathing	½" Plaster on 1" Rigid Insulation on Sheathing	½" Plaster on ½" Corkboard on Sheathing	Same as A but with Sisal Paper on Studs with Full Thickness Insulation against Sheathing	Same as B plus ½" Flexible Insulation against Sheathing	Same as B plus 3½" Rock Wool between Studding
41	Wood Siding or Clapboard	Wood Sheathing - 1"	0.25	0.24	0.19	0.15	0.11	0.19	0.17	0.066
42		Rigid Insulator Sheathing - ½"	0.23	0.22	0.18	0.14	0.11	0.18	0.16	0.059
43		Plaster board Sheathing - ½"	0.28	0.27	0.20	0.16	0.12	0.21	0.18	0.062
44	Wood Shingles	Wood Sheathing - 1"	0.24	0.23	0.18	0.14	0.11	0.18	0.16	0.059
45		Rigid Insulator Sheathing ½"	0.19	0.19	0.15	0.12	0.10	0.15	0.14	0.056
46		Plaster board Sheathing - ½"	0.24	0.24	0.19	0.15	0.11	0.19	0.16	0.060
47	Stucco	Wood Sheathing - 1"	0.31	0.29	0.22	0.16	0.12	0.22	0.19	0.063
48		Rigid Insulator Sheathing - ½"	0.27	0.26	0.20	0.16	0.12	0.20	0.18	0.061
49		Plaster board Sheathing - ½"	0.40	0.38	0.26	0.19	0.14	0.27	0.22	0.066
50	Brick Veneer	Wood Sheathing - 1"	0.23	0.23	0.18	0.14	0.11	0.18	0.16	0.059
51		Rigid Insulator Sheathing - ½"	0.23	0.22	0.18	0.14	0.11	0.18	0.16	0.059
52		Plaster board Sheathing - ½"	0.31	0.30	0.22	0.17	0.12	0.22	0.19	0.063

WOOD FRAME PARTITIONS

Construction No.	Finish	A	B	C	D	E	F
		Single Partitions (one side open)	Double Partitions				
			Air Spaces Between Studding	Gypsum Fill Between Studding	One side of Stud Space Faced with Bright Alum. Foil	½" Flexible Insulation Between Studding (no Air Space)	3½" Rock Wool Fill between Studding
53	Plaster on Wood Lath or ⅜" Plasterboard	0.60	0.33	0.11	0.24	0.21	0.063
54	Plaster on Metal Lath	0.68	0.38	0.11	0.27	0.22	0.065

WOOD FRAME FLOORS & CEILINGS

Construction No.	Ceiling Material	Insulation between Joists	A	B	C	D	E
		Type of Flooring →	No Flooring	Flooring (1" ft) on Joists	Flooring (1" ft) on ½" Rigid Insulation on Joists	H W Flooring on 1" ft Sub-Flooring on Joists	⅜" Battleship Linoleum on 1" ft. Flooring
55	No Ceiling	No Insulation	—	0.45	0.27	0.34	0.34
56	Plaster on Wood Lath or ⅜" Plasterboard	No Insulation	0.60	0.28	0.20	0.24	0.24
57	Plaster on ½" Rigid Insulator	No Insulation	0.34	0.21	0.16	0.18	0.18
58	Metal Lath Plaster	½" Rigid or Flexible	0.25	0.17	0.14	0.15	0.15
59	Metal Lath Plaster	Bright Aluminum Foil	0.29	0.22	0.17	0.19	0.19
60	Metal Lath Plaster	3½" Rock Wool	0.066	0.062	0.056	0.059	0.059
61	1½" Corkboard & Plaster	No Insulation	0.16	0.12	0.10	0.11	0.11

CONCRETE FLOORS

Construction No.	Construction Type	Thickness of Concrete	A	B	C	D	E
			Bare Concrete Floor	½" Flooring on Wood Sleepers Embedded in Concrete	½" Flooring on ½" x 2" H.W. Flooring on Wood Sleepers Embedded in Concrete	1" Tile or Terrazzo on Concrete	⅜" Battleship Linoleum on Concrete
62	A — Floor Slab Exposed No Finished Ceiling Beneath.	4	0.63	0.39	0.30	0.50	0.48
63		6	0.57	0.37	0.28	0.45	0.40
64		8	0.52	0.35	0.27	0.50	0.38
65		10	0.48	0.33	0.26	0.45	0.35
66	A — ½" Plaster Direct on Under Surface of Concrete	4	0.60	0.37	0.28	0.55	0.44
67		6	0.52	0.35	0.27	0.50	0.38
68		8	0.48	0.33	0.26	0.47	0.36
69		10	0.45	0.31	0.25	0.43	0.34
70	A — ¾" Plaster on Wood or Metal Lath (Suspended or Furred Ceiling)	4	0.37	0.27	0.22	0.36	0.29
71		6	0.35	0.26	0.21	0.31	0.28
72		8	0.33	0.25	0.21	0.31	0.25
73		10	0.31	0.24	0.20	0.30	0.24
74	A — ½" Plaster on ½" Rigid Insulation (Suspended or Furred Ceiling)	4	0.26	0.20	0.17	0.23	0.21
75		6	0.23	0.19	0.16	0.21	0.20
76		8	0.22	0.18	0.16	0.22	0.19
77		10	0.22	0.18	0.16	0.21	0.19
78	A — ½" Plaster on 1½" Corkboard in 1½" Cement Mortar on Concrete	4	0.15	0.13	0.12	0.13	0.13
79		6	0.14	0.13	0.11	0.14	0.13
80		8	0.14	0.12	0.11	0.14	0.13
81		10	0.13	0.12	0.11	0.13	0.12
82	B — Stone Concrete Directly on Ground, no Insulation, no Cinder Concrete	4	1.05	0.52	0.37	0.95	0.59
83		6	0.80	0.48	0.34	0.83	0.54
84		8	0.78	0.44	0.32	0.71	0.49
85		10	0.69	0.41	0.31	0.65	0.46
86	B — 3" Cinder Concrete on Ground, Insulation on top of this, under Stone Concrete.	No Insulation	4	0.64	0.40	0.80	0.61
87		No Insulation	8	0.53	0.35	0.67	0.51
88		Rigid Insulation	4	0.21	0.18	0.21	0.18
89		2" Corkboard	4	0.12	0.11	0.10	0.12
90		2" Corkboard	8	0.12	0.11	0.10	0.12

WOOD FRAME PITCH ROOFS

Construction No.	Roofing Surface	Type Insulation	A	B	C	D	E	F
			No Ceiling	½" Plaster on Wood or Metal Lath or ⅜" Plasterboard	½" Rigid Insulation with or without ½" Plasterboard	½" Flexible Insulation on 1" Rigid Insulation	⅜" Plaster on 1½" Corkboard	½" Plaster on 2" Corkboard
90	Wood Shingles on Wood Strips	No Insulation	0.45	0.28	0.22	0 17	0 12	0 10
91	Asphalt Composition, Tile or Slate on Wood Sheathing	No Insulation	0.54	0 31	0.23	0.17	0.13	0.10
92	Wood Shingles on Wood Strips, or Asphalt Shingles, Composition Roofing, or Slate or Tile Roofing on Wood Sheathing	½" Flexible	0.25	0.16	0.15	0.12	0.098	0.084
93		1" Flexible	0.17	0.12	0.12	0 10	0.083	0.073
94		Aluminum Foil on one side of Air Space	—	0 23	0.18	0 14	0.11	0.092
95		3½" Rockwool	—	0.063	0.059	0.054	0.050	0.045

MASONRY PARTITIONS

		No Plaster	Plastered One Side	Plastered Both Sides
96	4" Hollow Clay Tile	0.43	0.40	0.36
97	4" Common Brick	0.49	0.45	0.41
98	4" Hollow Gypsum Tile	0.29	0.28	0.27

FLAT BUILT-UP ROOFS

Construction No.		Thickness of Roof Deck	A	B	C	D	E	F	G	H
			No Insulation	Rigid Insulation ½"	Rigid Insulation 1"	Rigid Insulation 1½"	Rigid Insulation 2"	Corkboard 1"	Corkboard 1½"	Corkboard 2"
99	Precast	1⅝	0.83	0.37	0.23	0.17	0.14	0.22	0.16	0.13
100	Concrete	2	0.81	0.36	0.23	0.17	0.14	0.22	0.16	0.13
101		4	0.71	0.34	0.22	0.17	0.14	0.21	0.16	0.12
102		6	0.64	0.32	0.21	0.16	0.13	0.20	0.15	0.12
103	Wood	1	0.50	0.28	0.20	0.15	0.12	0.19	0.14	0.11
104		1½	0.37	0.24	0.17	0.14	0.11	0.17	0.13	0.11
105		2	0.32	0.22	0.16	0.13	0.11	0.16	0.12	0.10
106		4	0.18	0.14	0.12	0.10	0.085	0.11	0.094	0.081
107	2" Gypsum Fiber Concrete on ½" Plasterboard	2½	0.38	0.24	0.18	0.14	0.12	0.17	0.13	0.11
108		3½	0.31	0.21	0 16	0 13	0.11	0.15	0.12	0.10
109	Flat Metal	-	0.94	0.39	0.24	0.18	0.14	0.23	0.16	0.13
110	Precast	1⅝	0.42	0.26	0.18	0.14	0.12	0.18	0.14	0.11
111	Concrete	2	0.42	0.26	0.18	0.14	0.12	0.18	0.14	0.11
112		4	0.39	0.25	0.18	0.14	0.12	0.17	0.14	0.11
113		6	0.37	0.24	0.17	0.14	0.11	0.17	0.13	0.11
114	Wood	1	0.32	0.21	0.16	0.13	0.11	0.15	0.12	0.10
115		1½	0.26	0.23	0.15	0.12	0.10	0.14	0.11	0.098
116		2	0.24	0.21	0.14	0.11	0.097	0.13	0.11	0.091
117		4	0.15	0.12	0.10	0.088	0.078	0.10	0.085	0.074
118	2" Gypsum Fiber Concrete on ½" Plasterboard	2½	0.27	0.19	0.15	0.12	0.10	0.14	0.11	0.096
119		3½	0.23	0.17	0.13	0.11	0.098	0.13	0.11	0.096
120	Flat Metal	-	0.45	0.27	0.19	0.15	0.12	0.18	0.14	0.11

WINDOWS & SKYLIGHTS

121	Single Sash	Double Strength Window Glass ⅛ in Thick	1.24
122	Double Sash		0.58
123	Triple Sash		0.38
124	Double Glazed Single Sash		0.65
125	Plate Glass ¾ in Thick		1.19

WOOD & METAL DOORS

126	Thin Wood Doors with Glass	1.24
127	1" Wood Doors	0.70
128	2" Wood Doors	0.45
129	3" Wood Doors	0.30
130	Metal and Asbestos Doors	0.65

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HEAT TRANSMISSION TABLES

(Values of Coefficient U)

The values of U which appear on this sheet (79-80) are the same as those for masonry walls on H. & V.'s Reference Data 71 and 72; for wood constructions, on H. & V.'s Reference Data 73 and 74; for various floors, ceilings, roofs, and partitions, on H. & V.'s Reference Data 75 and 76, and for roofs, windows, skylights, and doors, on H. & V.'s Reference Data 77 and 78. They are republished so as to condense all of the information on a single sheet for those who can use these data in a form in which a certain amount of legibility is sacrificed for simplicity.

The tables on the other side of this sheet give the values of U for various types of building constructions. U is the amount of heat in B.t.u. passing through 1 sq. ft. of surface in 1 hr. when there is a 1 F difference in air temperature between the inside and the outside of the construction. The masonry walls, wood frame walls, wood frame pitched roofs, flat and built-up roofs, windows, skylights, and wood and metal doors are assumed to have still air on the inside and a 15 m.p.h. wind on the outside. The wood frame partitions, floors and ceilings, the masonry partitions and the concrete floors and ceilings, not including those resting on the ground, are assumed to have still air on both sides. Floors resting directly on the ground have only one surface resistance since the lower surface is in contact with the ground.

The value of U is for substitution in the following formula to estimate the amount of heat transmitted:

$$H = A\,U\,(t_i - t_o)$$

where H is the total amount of heat in B.t.u. per hour passing through a construction of area A. The temperature of the indoor air is represented by t_i and that of the outdoor air by t_o. Data for the selection of these indoor and outdoor design temperatures are given on H. & V.'s Reference Data 57 and 58. (In calculating H for floors laid directly on the ground, t_o represents the ground temperature. If the floor is below the frost line, it is common practice to use 50 F for the ground temperature.)

Values of U have been calculated from the best available data on heat conductivity. These data for a large number of materials have been gathered together and appear on H. & V.'s Reference Data 69 and 70. Persons interested in making their own calculations of values of U for any construction not included here will find the method outlined on H. & V.'s Reference Data 69 and 70.

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Weather Forecasting Progresses; Problem Studied by Various Agencies

A NOTABLE step toward temperature forecasts for approximately two weeks in advance, based on short-period fluctuations in the sun's output of radiant energy, was reported to the National Academy of Sciences April 27 by Dr. Charles G. Abbot, secretary of the Smithsonian Institution.

Doctor Abbot demonstrated to the National Academy that increases and decreases of solar radiation are accompanied by definite patterns of temperature variation for different seasons and different locations.

The amount of solar heat falling on the earth's surface from day to day varies. The most obvious of its variations are falls and rises through a range seldom exceeding seven-tenths of one per cent and seldom lasting more than a week. The temperature variations from normal accompanying such falls and rises may reach maxima as great as 10°, Doctor Abbot showed.

This basis of forecasting, he emphasized, is at present purely empirical and difficult to explain theoretically. It is distinct from the cyclic weather variations accompanying cyclic solar radiation changes which have been worked out by Doctor Abbot in the past and which extend over long periods of months and even years.

The fact remains, he reported, that when the solar radiation output starts to fall, in January for example, there is a specific pattern of rising and falling temperature in the city of Washington for a 17-day period. The same is true from the time the radiation starts to rise. These temperature patterns for rising and falling radiation are opposite, as the right hand is to the left. Both rising and falling patterns are quite different for February but still opposite to each other. They are different for each month and for each place. The greater the radiation changes the greater the temperature changes.

Doctor Abbot determined these patterns, based on solar radiation fluctuations over a 12-year period, for each month of the year at Washington, St. Louis, and Helena, Mont. Superficially, at least, there is a general similarity in the monthly patterns for the different places. For each month and each location, the rising and falling patterns are about equal and opposite.

The changes in temperature produced by changes of solar radiation, he pointed out, are of such magnitude as to leave little doubt that the latter are major factors in the earth's weather. The greater the change in radiation the greater the change in temperature.

He did not set forth his discovery as of immediate value in forecasting. It would first be necessary to work out the specific patterns for every part of the United States, just as he has done for Helena, St. Louis, and Washington. New York or Miami, for example, might have quite different patterns from any of the three worked out, and one cannot be deduced from another.

Moreover, in order that the method be of service in actual forecasting, it would be necessary to have extremely accurate observations of the solar radiation nearly every day of the year. The Smithsonian Institution now operates three observing stations under Doctor Abbot's direction — on Mount Montezuma, Chile; Mount St. Katherine on the Sinai Peninsula, and Table Mountain, California. In order to obtain a reliable measurement for any particular day it is essential that observing conditions be excellent at at least one of these stations. For reliable daily service, Doctor Abbot said, it would be necessary to have at least ten such stations scattered over the high mountain tops of the earth.

If means to establish and maintain ten such stations now were available, he said, it would be possible to begin to test this method of forecasting by 1940.

Various approaches to a clearer understanding of weather behaviour are being made in many places. The U. S. Weather Bureau, under a small WPA project, is carrying on an investigation of weather changes at various points in the United States and in other countries to determine whether weather changes in one part of the world may be of use in forecasting weather developments in other parts. Other institutions and private agencies are studying ocean temperatures, terrestrial magnetic phenomena, lunar phenomena, planetary movements, etc. Contributions to the problem of long-range weather and crop forecasting, it is hoped, may emerge from each of these lines of research.

Under the allocation of funds by the Secretary of Agriculture for the fiscal year 1935-36, two lines of work have been undertaken. One has to do with a survey and critical appraisal of methods now employed in attempts at long-range weather forecasting by foreign countries and by private individuals and agencies in this country. This survey should give a basis for research projects to be organized during the fiscal year 1936-37 and thereafter. The other has to do with a similar survey of the relationship of weather to crop yields as revealed by studies already made in the Department of Agriculture by the Weather Bureau, the Bureau of Agricultural Economics, and the various state institutions. From this preliminary survey the Department expects to develop more intensive research in crop yield variations and weather factors during the 1936-37 and subsequent fiscal years.

Be sure to read page 29 where full information is given about HEATING & VENTILATING'S DEGREE-DAY COMPETITION, with $160 in awards

EDITORIALS

Heating the Housing Projects

The groups of large apartment buildings erected by PWA during the course of the past several years have served to draw attention to heating practices in supplying heat to building groups. These plants are comparable to institutional plants and in some cases the total demands are sizable. Not in years, if ever, have so many new central heating plants been installed for heating groups of buildings. The methods, while in the main those well established, do contain some innovations. Believing that certain phases of these plants are of widespread interest, we have collected some of the principal features and present this information elsewhere in this issue. The whole subject of the venture of the federal government into housing construction and finance is still debatable but questions of public policy need not confuse the details of the heating methods used. These methods are likely to affect practice in group projects of this kind for some time to come and are worthy of your attention.

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Silicosis and Industrial Ventilation

Interest in industrial ventilation seems to move in cycles. No individual factory management, no matter how sympathetic it may be toward its factory personnel, feels that any notable expenditure can be made for ventilation unless there is a real reason for it. In a given case it is difficult to determine when the necessity is real. The result all too frequently is that little is done until there is some compulsion. Usually the compulsion comes either through law or through complaints or lawsuits on the part of labor. Just before the war there was a considerable wave of interest and factory laws were enacted and inspection was set up.

Now the flurry over silicosis, its causes and effects on labor, and the legal liabilities involved have revived interest. There is a considerable likelihood that all phases of the subject are going to be looked into. We can hope that the examination will not only be searching but that it will be productive of improvements in both design and operation of factory ventilation plants for keeping the harmful silica particles within bounds of safety. Perhaps, too, the organization being set up will be able to codify its findings to such an extent that we shall have a better organized body of information on the whole subject of factory exhaust systems. It is badly needed, for the problem is a real one and the present practices are almost entirely based on rule of thumb both in design and in checking on results obtained.

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Air Conditioning Retailers

Discussions of the relative merits of various groups as a means of marketing equipment for air conditioning are endless. The principal cleavage is between the long established contractors who have traditionally worked with owners and with their engineers and architects and the newer dealers who resort more to display and to direct solicitation of owners. At present neither group has succeeded in establishing its efficiency beyond question. Each has strong arguments to advance as to why it is the group to be preferred.

As a matter of fact it is true that both groups are going through a transformation period. What will ultimately emerge is still in the lap of the gods. Certain it is that there must be an adequate group to act as retail outlets. Certain it is also that problems of application, of installation including the necessary labor, and of service are going to continue to loom large in the marketing picture. Ability to find a prospect and make a sale is by no means the whole requirement in marketing this equipment, although a very necessary feature. An installed job must stay sold regardless of who sells it and who installs it.

It has always seemed to us that the established contractor group should be regarded as the one best qualified to act as retail outlet. This in spite of the admitted fact that many of them were not sales-minded and that they were not organized to go out aggressively after all kinds of business. They did possess two assets of unquestioned value in that they had good local connections and a good background of both organization and knowledge of application, installation and service. We have felt that these assets formed a good basis on which to build. We still think so.

The dealer group was recruited from many sources. Generally it is long on selling ability and short on background and on local connections. Whatever building is done has to be on what exists and the missing elements have to be supplied.

As the educational work has gone on the distinction between dealer and contractor has become less and less meaningful so far as function is concerned. Now in certain localities there are firms in each group which do essentially the same work. All this is merely an indication that neither the contractor nor the dealer group can get along without making whatever changes are necessary in its thinking, its methods, and its organizations.

It would seem that the time has now come when the questions of marketing can turn definitely from which group is best qualified to questions of which individual firms are best qualified for a specific product in a particular locality. When things reach this stage it will indicate that the end of the transformation period is in sight. The resulting retailer must be capable in all directions and his group origin will not be nearly so important as his results.

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Another Year of Modernizing Insurance

Extension for one year of the modernizing insurance section of the Federal Housing Act finally pulled through. The building industry on the whole seemed rather indifferent to the extension but the floods and the resulting cry for help acted as persuasive arguments. The new provisions are stricter than the former ones. Equipment like washing machines and kitchen refrigerators are not eligible now. Heating and air conditioning equipment is still eligible, though, when added to a property on which there is a completed building. The consensus of opinion seems to be that the modernization insurance feature is still attractive to buyers and lenders and that the restrictions will not seriously interfere with the former situation. Extension of Title I of the act beyond the current year is scarcely to be expected. The provision of the insurance, however, certainly did mark the turning point of the building industry and the plan can be given credit for stimulating activity when it was badly needed. Certainly the whole problem of modernization is now in better shape and its possibilities are better understood as a result of the work of FHA. Hereafter it will probably be left to individual effort to continue to realize on its possibilities.

NEWS OF THE MONTH

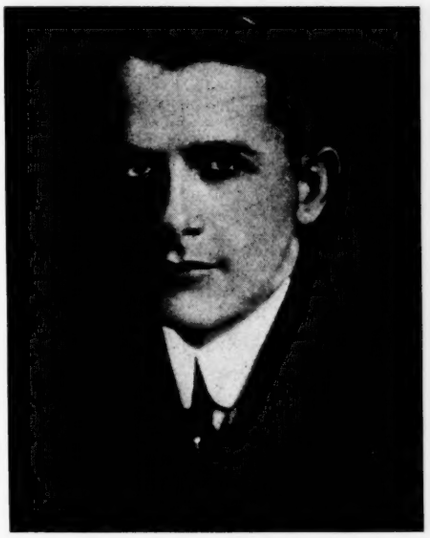
Contractors Meet in Philadelphia, Stress Importance of Sales, Elect Zink President

PHILADELPHIA — Increased attention to the sales problem marked the three-day, 47th annual convention at the Heating, Piping & Air Conditioning Contractors National Association's meeting here May 25-27. Not only was one of the four sessions of the convention devoted to the subject of sales, but the subject ran through the other sessions as well. The program also provided both evening entertainment and the usual golf tournaments which occupied the attention of the group on Tuesday afternoon. The total registration reached a figure approaching 250, bringing it well into line with attendance figures of recent years.

At the closing session on Wednesday morning, John H. Zink, Baltimore, was elected president; George H. Dickerson, Chicago, was made vice-president; Maurice J. Chagnard, Louisville, treasurer; Joseph C. Fitts, New York, secretary, and S. Lewis Land, New York, educational director. Election of the board of directors placed S. Austin Pope, Chicago, and J. M. Anderson, Philadelphia, on the board.

Reports of the officers and of the active committees were available for members in printed form and reflected the close attention given by the committees and also the management during the past year. The secretary reported with pleasure the maintenance of a good financial position, in spite of unexpected expenditures and changes in the program of the association's work.

Outstanding in the convention was a sales clinic. Here A. R. Herske, vice-president and general sales manager, American Radiator Co., presented the viewpoint of the manufacturer; William A. Brecht, president, Hajoca Corp., gave the wholesaler's, while J. Lawrence DeNeille and Joseph C. Fitts presented the contractor's point of view. This session also gave consideration to the newly-organized movement to promote the sale of air conditioning with radiator heat, while the paper of DeNielle and Fitts presented a nine-point program and platform for the sales activities of the association and its members. Their program advocated no particular change in the method of selling, except that the comfort motive should be stressed instead of equipment; that certified heating be promoted wherever possible. They felt that the association should attempt to find out what the public wants to buy, and that the definition of air conditioning as set up by the Better Business Bureau should be adopted by the association and made the basis of its promotional work. They felt, too, that the ultimate aim of the selling effort should be to sell year 'round conditioning where possible for commercial uses and for the home as well. The primary effort, however, should be directed toward winter air conditioning, with secondary emphasis on the summer phases. They advocated a thorough understanding on the part of the contractor of the fact that he is both a retailer and installer, and that the sales promotion program of the association should continue to draw the attention



John H. Zink, newly-elected president of HP&ACCNA.

of everyone interested to the fact that the contractor is the logical retail outlet for all the products of the industry. They felt that such a sales program was not only desirable from the standpoint of the association and its members, but that it was drawn in broad enough terms to attract the support of the other elements of the industry as well.

When NRA went out of existence shortly after the close of the last convention the association's program was left in confusion. In the intervening months attention has been turned to the possibility of developing a method of enforcement through voluntary codes. In Chicago, this movement has reached considerable proportions and met with a considerable measure of success, as reported by Joseph P. Baldwin on Tuesday morning. Secretary Oleson of the Boston local association also reported informally on the progress made in that city. It was the feeling of the speakers that a good deal can be done locally by proper organization and planning in connection with voluntary codes, where labor acts as an essential part of the enforcement method. They felt that a good deal was to be gained by a careful study of the matter of voluntary codes on the part of local contractors throughout the country.

F. C. Fantz, chairman of the welding committee, led a discussion following the report of his committee during the Tuesday morning session. In response to questions from the floor he explained the relation of the Code for Pressure Piping of the ASA, and the qualifications of welders by the individual contractor.

Walter L. Fleisher, New York, closed the Tuesday session with an address entitled "Air Conditioning From a Promotional Angle," in which he dwelt on the relative importance of winter conditioning including humidification as opposed to summer phases.

The Wednesday morning session was devoted to committee reports on certification, standards, and on boiler output, each of which subjects was reported on by the committee chairman, and drew discussion from the floor.

The Social Security legislation, which is now in effect, and more of which is in the offing, was covered by the Hon. Vincent M. Miles of the Social Security Board. He called attention to the nature of the legislation now in existence, and to the requirements which it sets up. John H. Zink, incoming president, reported on the activities of the Construction League and the U. S. Chamber of Commerce, on both of which bodies he has acted as the association's representative. The convention closed with election of officers and with the afternoon session scheduled for Wednesday moved forward into the morning.

A.C. on "Queen Mary"

NEW YORK—The Cunard White Star Liner *Queen Mary* arrived here June 1, following a trip somewhat hampered by fog. The new British superliner has five independent air conditioning plants with a combined capacity of nearly 7,000,000 cu. ft. per hr.

This ship is the first to have a steam ejector water cooler for air conditioning purposes. The steam ejector system cools the main dining saloon and the lounge, the former being the largest room ever built into a ship—3 decks high, 118 ft. wide, and 160 ft. long.

Refrigeration for the tourist saloon is supplied by a CO_2 plant, while the beauty parlor has an independent methyl chloride refrigerating machine. Pneumatic controls are used.

NDHA to Convene in Michigan

GRAND RAPIDS, MICH.—The 27th annual convention of the National District Heating Association will open at the Pantlind Hotel here the morning of Tuesday, June 16. Wm. H. Sanford, the new secretary of the Association, will be in charge of registration.

The convention will be concluded at noon, June 19, the annual banquet being held Thursday evening, June 18. The program follows:

JUNE 16

10:30 a.m.

Welcome Address, D. E. Karn, vice-president and general manager, Consumers Power Co., Jackson, Mich.

President's Address, Robert L. Fitzgerald, Duluth Steam Corp.

Report of Educational Committee, D. S. Boyden.

Report of Acting Secretary-Treasurer, Miss M. C. Stocker.

2:30 p.m.

Report of Commercial Relations Committee, Leonard S. Philips.

Report of Sales Development Committee, R. J. J. Tennant.

Salesmanship, Edward Weir.

8:30 p.m.

Report of Hot Water Committee, F. L. Witsell.

Report of Operating Statistics Committee, A. D. Leach.

Report of Manufacturers' Committee, H. C. Kimbrough.

Visit by Members to Manufacturers' Exhibition Booths.

JUNE 17

9:30 a.m.

Report of Distribution Committee, G. D. Winans.

Report of Meters and Accessories Committee, W. W. Stevenson.

JUNE 18

9:30 a.m.

Report of Steam Station Engineering Committee, A. R. Mumford.

Report of Research Committee, G. K. Saurwein.

Report of Chemistry Committee, Harold Farmer.

JUNE 19

9:30 a.m.

Report of Rates and Regulations Committee, J. M. Arthur, Jr.

Report of Bulletin Publication Committee, Landis S. Smith.

A.C. Builders Adopt Standards

HOT SPRINGS, VA.—The Air Conditioning Manufacturers' Association held its annual meeting here May 16 under the chairmanship of P. A. McKittrick, Parks-Cramer Co., Fitchburg, Mass. An outstanding feature of the meeting was the presentation of an air conditioning applications code for the use of the Association's members, pending the drafting of a national code under the sponsorship of the technical societies interested in the air conditioning field. The applications standards code submitted by the technical and code committee through its chairman, Donald French, was approved by the Association and will be released for publication shortly.

A review of the standardization program undertaken by ACMA during the past year showed that substantial progress had been made. Various recommendations of the standards committee were presented to the meeting and a number of standards approved.

J. F. G. Miller, newly-elected president of ACMA.

Officers elected were: President, J. F. G. Miller, B. F. Sturtevant Co.; vice-president, J. A. Harlan, Kelvinator Corp.; treasurer, P. A. McKittrick.

The board of directors elected for the year 1936-37 were: Chairman, S. E. Lauer, York Ice Machinery Corp.; W. F. Armstrong, Delco-Frigidaire Conditioning Corp.; P. Y. Danley, Westinghouse Electric & Mfg. Co.; J. J. Donovan, General Electric Co.; William H. Price, Jr., Carrier Engineering Corp.. and Messrs. Harlan, Miller, and McKittrick.

Canadians to Cooperate in Research

TORONTO, ONT.—The feature of the March meeting of the Toronto chapter of the ASHVE was an address by C. Tasker, who was elected to the ASHVE committee on research at the annual convention in Chicago for a three-year period. He dealt with the importance of research in the air conditioning industry. For the first time in the history of the Ontario Research Foundation, it is to cooperate with the ASHVE for the benefit of the industry.

E. L. Anderson, director of Canadian Sirocco Co. Ltd., gave an illustrated talk on Sound.

Rumor Ford to Make Heating Equipment

NEW YORK—Rumors are making the rounds among advertising men that Ford Motor Co. may enter the electrical refrigeration field, and later begin manufacturing oil burning heating equipment. Officials are said to deny knowledge of these developments.

ASHVE Prepares for Joint Meeting with ASRE

NEW YORK—The revised program of the semi-annual meeting of the ASHVE, to be held at the Inn, Buck Hill Falls, Pa., June 22-24, has been released.

The men's golf tournament will be held Monday afternoon on the Buck Hill course and at six that evening the party will leave for a picnic on Skytop Mountain with the ASRE members.

The Research Cup Golf Tournament will be held Tuesday afternoon.

The technical program follows:

MONDAY, JUNE 22

Corrosion Studies in Steam Heating Systems, by R. R. Seeber, F. A. Rohrman, and G. E. Smedberg.

Performance of an Underfeed Domestic Stoker, by T. G. Estep and D. C. Saylor.

Relative Absorption of the Various Sections of a Round Heating Boiler, by A. J. Johnson and Paul A. Mulcey.

The Distribution of Steam in Heat Transfer Surface, by John McElgin.

TUESDAY, JUNE 23

Theory and Practice of the Heat Pump, by C. W. Chamberlain.

Application Factors Which Govern the Selection of Refrigerating Equipment for Air Conditioning Service, by J. R. Hertzler.

Water Supply as Affected by the Demand for Summer Air Conditioning, by D. C. Morrow.

A Quarter Century's Progress in Air Conditioning, by W. H. Carrier.

WEDNESDAY, JUNE 24

Development of Testing Apparatus for Thermostats, by D. D. Wile.

Pyroheliometers and the Measurement of Total Solar Radiation, by L. A. Harding.

A Field Study of the Heat Requirements of a College Building, by F. E. Giesecke, W. H. Badgett, and Carl Gutberlet.

Heating Requirements of an Office Building as Affected by Weather Conditions, by F. C. Houghten.

The technical sessions will be held at 9:30 a.m., the one on Tuesday being a joint session with the ASRE which is holding its summer meeting at Skytop, a few miles from Buck Hill Falls. The joint session will be held at Buck Hill.

A vote will be taken at the semi-annual meeting on several amendments to the Constitution and By-Laws of the ASHVE. One calls for the remitting of dues of any person who has been a member of the Society for 15 years or more and has reached the age of 70. The remitting of dues would not involve surrendering any of the privileges of membership.

The second amendment calls for the pro-rating of the dues of a new member of any grade. Under this amendment if the amount thus paid is less than five dollars the member would not be entitled to receive the *Transactions* or the *Guide* for that year.

A third proposal provides that the standards committee shall consider all questions pertaining to the establishment and revision of Society standards and shall report its findings to the Council.

Hospital and Candy Factory Conditioning Discussed

CHICAGO—W. L. Krogman, engineer for the University of Chicago, addressed the monthly meeting of the Illinois Chapter, ASHVE, at the Hotel Sherman, May 11. His subject was "Conditioning Operating Rooms, Billings Hospital, University of Chicago."

Mr. Krogman said that three operating rooms and one large amphitheater in the hospital were provided with complete air conditioning, utilizing much of the existing plant already at the institution. He described a circular device projecting to within 10 ft. of the floor from the center of the ceiling, whereby the air was admitted to the room at a velocity of 350 f.p.m. and the exit through the center of this device so that there were no drafts on the patient or the operating staff.

The cooling was designed on a differential of 12F and relative humidity of 35% to 40%. The inadvisability of recirculating any of the conditioned air while operations were in progress was emphasized.

Roy W. Shields, assistant engineer, Samuel Lewis and Co., spoke on "Air Conditioning Requirements in a Candy Factory." He stated that the making of an assortment of candies requires a variety of air conditions. Air at about 50F is used for cooling hard candy to give a glistening surface. A room at from 80F to 85F and a relative humidity of less than 40% is required for packing due to the hydroscopic nature of candy of this type.

The enrobing or chocolate covering process necessitates a room at 80F and 15% relative humidity. Air at about 40F is used in the tunnel where the chocolate coating is cooled and hardened. The internal temperature of the cream should be reduced to 67F for packing, which is done in a room maintained at 60F and 50% relative humidity. To give a smooth and tender surface, marshmallows require a conditioning room having an average temperature of 47F and 55% relative humidity. However, as marshmallows have a tendency to lose moisture when exposed to dry air, a higher relative humidity is maintained in the conditioning room in cold weather so that the candy will have a slightly higher moisture content when packed for winter sale.

Kroeker Heads Firm

PORTLAND, OREG.—The Columbia Engineering Co., Inc., has been formed here to act as engineers and consultants in heating, ventilating, and air conditioning. The president is J. Donald Kroeker, registered mechanical engineer. The new firm will be located at 610 Failing Building. Catalogs are requested from manufacturers.

Warm Air Men to Meet in Columbus

COLUMBUS, OHIO—Members of the National Warm Air Heating and Air Conditioning Association who attend the mid-year convention of the Association at the Deshler-Wallick Hotel here June 16-18, have been invited by Battelle Memorial Institute of Industrial and Scientific Research to visit its laboratory during their stay.

President W. L. Rybolt will act as chairman of both the morning meetings while L. R. Taylor, first vice-president, will preside in the afternoon.

The golf tournament will be held at 1:30 p.m. June 18.

The program follows:

JUNE 17

10 a.m.

Talk on Merchandising, R. D. Marshall.

Why Not A Profit From Air Conditioning, Harold S. Sharp.

Prefabricated Ducts, Harry R. Jones.

2 p.m.

Research in Summer Cooling, M. K. Fahnestock, University of Illinois.

Automatic Controls for Warm Air Heating and Other Phases of Air Conditioning.

JUNE 18

9:30 a.m.

Installation Codes Committee Report, Prof. J. D. Hoffman, chairman.

Research Advisory Committee Report, F. G. Sedgwick, chairman.

A Resume of Our Research Work on Forced Air Heating and Its Practical Applications, A. P. Kratz, Research Professor, University of Illinois.

Performance of Oil Burning Furnace in Research Residence, S. Konzo, Special Research Associate, University of Illinois.

N. J. Dealers Organize

NEWARK, N. J.—An organization of dealers with a reputation for quality of service in selling and installing air conditioning systems, has been formed here under the name Air Conditioners Association of New Jersey. It was formally organized May 18 and will have headquarters at 405 Federal Trust Building. Anthony Menke, general manager of the Menke Air Conditioning Company, was elected president.

The Association will cooperate with city councils and other groups in legislative movements to protect owners of buildings against inefficient air conditioning systems. The recently adopted air condition code of Montclair is expected to serve as a model which the Association will propose that other New Jersey cities adopt.

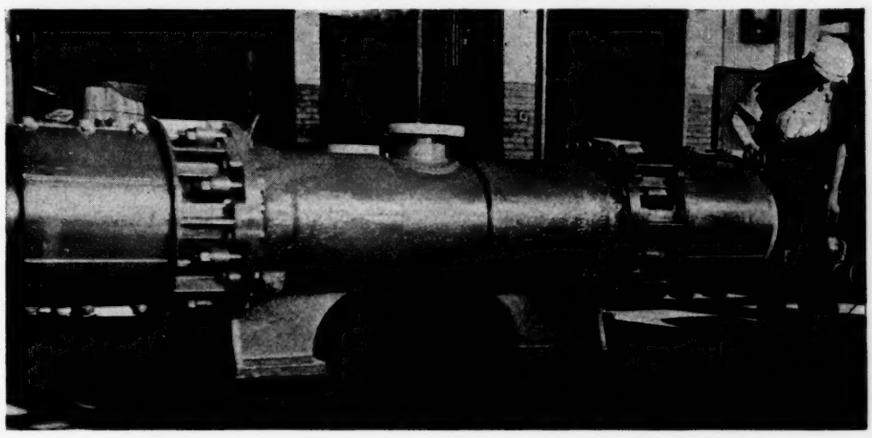
A school of air conditioning engineering will be conducted on Monday evenings at 8 o'clock by the educational committee. The course will include methods of caculating heat losses and heat gains and layouts. Other officers of the Association were elected as follows: vice-presidents, R. F. Stengel, Irvington, Wm. E. Parkin, Summit, and William J. Steinbrecher, Lakewood; secretary, Robert A. Mager, South Orange; treasurer, Edward H. Kuhles, Irvington.

Contractors Elect

KANSAS CITY, MO.—The Heating, Piping and Air Conditioning Contractors Association of Kansas City, Mo., recently elected the following officers: president, William Ball, Inter-State Heating & Plumbing Co.; vice-president, W. T. Conroy, Conroy Plumbing Co.; treasurer, Carl Smith, Magill Plumbing & Heating Co.; and secretary, Henry Nottberg, U. S. Engineering Co.

New Chapter Has Public Meeting

WINNIPEG, MAN.—Twenty-one members of the newly-formed Manitoba chapter of the ASHVE held their first public meeting in the Fort Garry Hotel recently, with J. B. Steele, president, in the chair. The guest speaker was J. W. Sanger.



One of the five 20-in., 300-lb. double expansion joints furnished to the Ford Motor Company by American District Steam Company, and believed to be the largest of their kind. These joints have cast steel bodies, two of which are joined together by a welded nipple, to which in turn an 8-in. vertical outlet is welded. The slips are steel with heavy chromium plating and provide 14 in. traverse on each slip, a total of 28 in. of traverse. The joints are to be used on 250-lb. pressure, 680F temperature service.

District Heating Men to Meet in Michigan

GRAND RAPIDS—The 27th annual convention of the National District Heating Association will be held here June 16-19, with headquarters at the Pantlind Hotel. Technical sessions will be held each morning, with extra sessions scheduled for the afternoon and evening of June 16.

The tentative program follows:

TUESDAY, JUNE 16
10:30 a.m.

Welcome Address—D. E. Karn, vice-president and general manager, consumers power Co., Jackson, Mich.

President's Address—Robert L. Fitzgerald, Duluth Steam Corp., Duluth, Minn.

Report of Educational Committee—D. S. Boyden, Edison Electric Illuminating Co., Boston, Mass.

Report of Membership Committee—R. M. Nee, Edison Electric Illuminating Co., Boston, Mass.

Report of Insurance Rates Committee—S. S. Sanford, Detroit Edison Co., Detroit, Mich.

Report of Acting Secretary-Treasurer—Miss M. C. Stocker, Greenville, Ohio.

2:30 p.m.

Report of Commercial Relations Committee—L. S. Phillips, New York Steam Corp., New York.

Report of Sales Development Committee—R. J. J. Tennant, The Allegheny County Steam Heating Co., Pittsburgh, Pa.

8:30 p.m.

Report of Hot Water Committee—F. L. Witsell, Toledo Edison Co., Toledo, Ohio.

Report of Operating Statistics Committee—A. D. Leach, Northwestern Electric Co., Portland, Oreg.

Report of Manufacturers' Committee—H. C. Kimbrough, American District Steam Co., N. Tonawanda, N. Y.

WEDNESDAY, JUNE 17
9:30 a.m.

Report of Distribution Committee—G. D. Wyans, Detroit Edison Co., Detroit, Mich.

Report of Meters and Accessories Committee—W. W. Stevenson, The Allegheny County Steam Heating Co., Pittsburgh, Pa.

Evening

Informal Dinner and Entertainment at Blythefield Country Club.

THURSDAY, JUNE 18
9:30 a.m.

Report of Steam Station Engineering Committee—A. E. Mumford, New York Steam Corp., New York.

Report of Research Committee—G. K. Saurwein, Harvard University, Cambridge, Mass.

FRIDAY, JUNE 19
9:30 a.m.

Report of Rates and Regulations Committee—J. M. Arthur, Jr., Kansas City Power & Light Co., Kansas City, Mo.

Report of Bulletin Publication Committee—Landis Shaw Smith, Rochester Gas & Electric Corp., Rochester, N. Y.

Manufacturers will have exhibits in rooms adjacent to the meeting room in the Pantlind. Exhibitors who have arranged to have space include:

E. B. Badger & Sons Co., Boston, Mass.; U. S. Steel Corp., Subsidiaries, Pittsburgh, Pa.; Warren Webster & Co., Camden, N. J.; Central Station Steam Co., Detroit, Mich.; Bailey Meter Co., Cleveland, Ohio; Bristol Co., Waterbury, Conn.; Ric-wiL Co., Cleveland, Ohio; Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.; American District Steam Co., North Tonawanda, N. Y.; Spence Engineering Co., New York; HEATING & VENTILATING, New York, and Jas. P. Marsh Corp., Chicago, Ill.

203 Attend A.C. Conference

URBANA, ILL.—Two hundred and three persons registered at the conference on air conditioning, held at the University of Illinois here May 4-5. This conference is said to be the first on the subject designed for non-technically trained citizens. Although this idea was stressed in advance publicity, about 60% of those attending were trained engineers.

Registration showed attendance from 11 states and one foreign country.

$260,000 for Ford Air Conditioning

DEARBORN, MICH.—A two-year program calling for the air conditioning of the administrative offices of principal branches of the Ford Motor Co. in the United States has been embarked upon. Installation of air conditioning units in the offices of Ford branches at Edgewater, N. J.; Somerville, Mass.; Chester, Pa.; Chicago, Kansas City, and Dallas, Tex., has been ordered carried out at once.

The entire program will require two years to complete. It is estimated at $260,000.

K.C. Bank Conditioned

KANSAS CITY, MO.—The first downtown banking institution in Kansas City, Mo., to install air conditioning equipment is the Mercantile Home Bank & Trust Co., 1119 Walnut St. The work is completed and the two first floors are now air conditioned. The equipment has a capacity of 20 tons.

A second bank to install air conditioning will be the Inter-State National Bank, located in the Live Stock Exchange Building.

A.C. for Southern Hotels

BIRMINGHAM, ALA.—The Dinkler Hotel chain in the south is going to give air conditioning a chance to prove itself by making installations on two bedroom floors in the Tutwiler Hotel in Birmingham and the Jackson Hotel in Nashville. Slightly more will be charged for the rooms on the conditioned floors in order to determine the reaction of guests.

The equipment used consists of a central unit, operating the entire outfit, but permitting control in each bedroom, just as heating is controlled in the winter.

Warm Air Group to Sponsor Campaign

CHICAGO—Leading manufacturers of warm air furnaces and associated air conditioning units are reported to have banded together for a widespread movement to be known as National Warm Air Heating and Air Conditioning Week. August 17-22 has been selected as the week of celebration. The movement is said to be for the purpose of enlightening the public on just what constitutes warm air heating and air conditioning.

A speakers' bureau, operated from the National Warm Air Heating and Air Conditioning Association offices in Columbus, will feature the week before civic bodies, state and local building groups, and FHA home show groups. Campaign headquarters are at 407 South Dearborn St.

A.C. for Union Office

KANSAS CITY, MO.—The first air conditioning system to be installed in an office building here was begun May 1 on the Brotherhood Building. This is a five-story building, owned by the International Brotherhood of Boilermakers, Iron Shipbuilders, Welders and Helpers of America. The total cost will approximate $37,000.

Alfred Phillip Mudgett

PHILADELPHIA—Alfred Phillip Mudgett, vice-president and general manager of Brown Instrument Co. died here May 8 following an operation for acute appendicitis.

Born in Hamilton, Ohio, November 15, 1889, Mr. Mudgett attended Purdue University in the class of 1913. After college he was associated with the Service Motor Truck Co., Wabash, Ind., and later with the Acme Motor Truck Co. and the Hudson Motor Car Co.

In 1924, Mr. Mudgett joined the Honeywell Heating Specialty Co. Following the merger of Minneapolis Regulator Co. and Honeywell in 1929 Mr. Mudgett became manager of the Wabash plant of the merged company. He was later made resident vice-president and branch manager of the New York office of Minneapolis-Honeywell, which position he held until January 1, 1936. At that time Brown Instrument Co. was acquired by Minneapolis-Honeywell as a subsidiary and Mr. Mudgett was chosen vice-president and general manager of the subsidiary company at Philadelphia.

He is survived by his widow, two daughters, one son, his father, three brothers, and one sister.

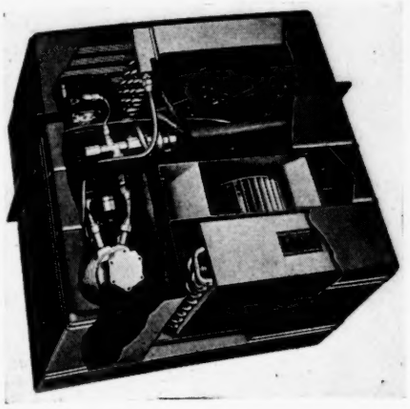
NEW EQUIPMENT

Aeriet Model A Conditioner

NAME AND MODEL NUMBER—Adco-Aeriet Model A air conditioner.

PURPOSE—Portable window units.

FEATURES—Has ½-ton V-8 compressor.



Cools, filters, dehumidifies, and circulates air. Space between unit and sash frame is closed by side panels. Adjustable ½-hp. non-radio interfering refrigeration motor, expansion coils, air impeller, 1/20-hp. fan motor, condenser, coil, grilles, drawer containing filter element and cutout switch. Requires no plumbing connections.

SIZES AND CAPACITIES—½-ton cooling unit. Will condition room of size from 1,600 to 2,000 cu. ft.

MADE BY—*Air Devices Corp., 210 S. Clark St., Chicago.*

Model 300 Sound Level Indicator

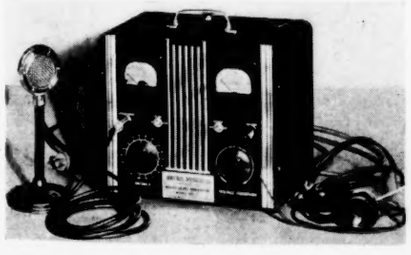
NAME AND MODEL NUMBER—Model 300 sound level indicator.

PURPOSE — For measuring intensity and character of sounds as heard by the ear.

FEATURES—Consists of a calibrated crystal type microphone, audio-frequency amplifier, calibrated attenuator, ear weighing filter, calibrated output or decibel meter, and crystal type headset. The attenuator is used to place the instrument within the wide range of sound encountered as the decibel meter is limited in its range to 16 decibels. The ear weighing filter is used so that the decibel meter will respond to sounds as they are actually heard by the human ear as the human ear is not equally sensitive to all frequencies of sound nor to all changes in intensities. The decibel meter is an output meter of the rectifier-milliammeter type. The device has a reference level of 10^{-16} watts. The frequency used as a basis of calibration is 1,000 cycles per second. This practice conforms to the proposed standards of the A.S.A.

SIZES AND CAPACITIES — Has a range from 20 to 102 decibels.

MADE BY—*Industrial Apparatus Co., 720 North Wabash Ave., Chicago.*



Hoffman 500 Conditioner

NAME AND MODEL NUMBER — Hoffman Model 500 air conditioner.

PURPOSE—For use in connection with radiator heating.

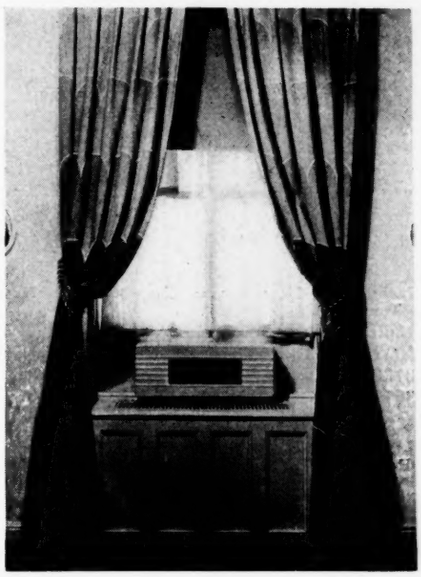
FEATURES — Humidifies, cleans, and circulates the air. Humidification is by a fine water spray; cleaning is by means of a dry 16 x 20 in. filter and air washer, with eliminator. Air is conducted through a duct system to registers under radiators in the room. Blower is provided with a motor-driven fan. Spray nozzle is of the Hoffman type and is self-flushing with a double jet impingement feature. Humidity is controlled by a standard solenoid valve. Fan is a slow speed forward curve multiblade type V-belt driven. Motor is 1,750 R.P.M. ⅛ hp.

SIZE AND CAPACITY—Available in one size with a capacity up to ten average rooms. With normal duct resistance unit has an air capacity of 450 c.f.m., a humidifying capacity of 20 gal. per day. Weight, 225 lb.

MADE BY—*Hoffman Specialty Co., Inc.*, 500 Fifth Ave., New York.

Davies Filteraire

NAME AND MODEL NUMBER—1936 model Filteraire unit.



PURPOSE—Circulating, filtering, and sound absorption unit for window application.

FEATURES—Has large centrifugal blower, Airplex air filter, and silencer. Finished in old ivory.

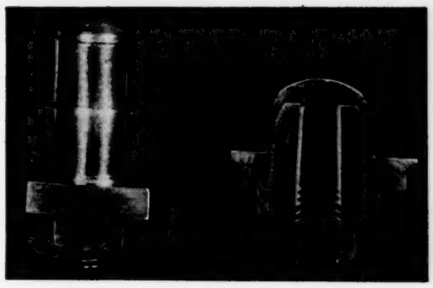
SIZES AND CAPACITIES—450 c.f.m. Available for a.c. or d.c. current.

MADE BY—*Davies Air Filter Corp., 390 Fourth Ave., New York.*

Multi-Seal Rivet

NAME—Multi-Seal steel mechanical rivet.

PURPOSE—For riveting metal together when it is impossible to work from both sides. The rivet is inserted and operated from only one side of the job, forming a steel rivet head on the inside. It incorporates a hardened steel bolt with a steel expansion ferrule under the head and resting on a steel body or shank which has a square head on one end. The nut locks the assembly in place. When inserted through a hole, the bolt head foremost, the square steel body is pressed to the work and the nut turned down, the expansion ferrule expands over the steel body and compresses to the work, drawing the square head



on the outside tight. It will withstand shear strains to 100,000 lb. Available in all sizes.

MADE BY—*Multi-Seal Mfg. Co., 123 N. Jefferson St., Chicago.*

Electromode Bathroom Convector

NAME—Electromode convection heaters.

PURPOSE—Electric heater especially intended for chilly bathrooms, as temperature booster in rooms hard to heat.

FEATURES—Element of cast aluminum. Heating is by means of a calrod, around which the element is poured. Shrinking of the metal in cooling causes calrod to become an integral part of the heating element.

SIZES AND CAPACITIES—A ¾-kw. unit.

MADE BY—*The Electric Air Heater Co., 555 Byrkit St., Mishawaka, Ind.*

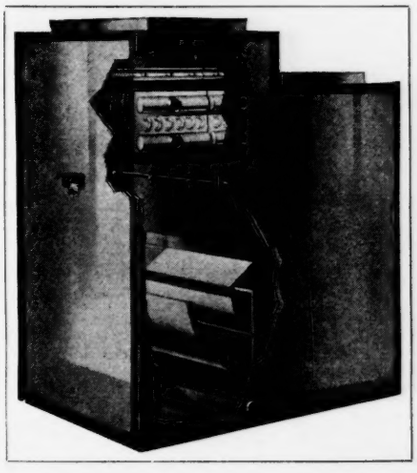
Electrol S-S Air Conditioner

NAME AND MODEL NUMBER—Electrol S-S Series Split-System conditioner.

FEATURES—Consists of a blower unit containing circulating fan, air filters, humidifier and heating coil. Designed to be connected to a radiator heating system to supply conditioned air to certain rooms.

SIZES AND CAPACITIES—Available in four models with heating capacities ranging from 365 to 1,275 sq. ft. of steam radiator, and with an air capacity of 1,120 to 3,600 c.f.m. With 40 F water the cooling capacity of the unit ranges from 34,250 B.t.u. to 98,500 B.t.u. per hr.

MADE BY—*Electrol Inc., 934 Main Ave., Clifton, N. J.*



Degree-Days for April, 1936

IMPORTANT—Users of the Degree-Day are urged to refer to page 29 of this issue where full information is given about HEATING & VENTILATING's DEGREE-DAY COMPETITION, with prizes totalling $160 for articles relating to your use of the Degree-Day.

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for April, 1936	605	232	403	182	598	770	716
Degree-days, Sept. 1, '35 to Apr. 30, '36.	6371	3278	4683	2925	5918	6913	7644
Degree-days, Sept. 1, '34 to Apr. 30, '35.	6356	2756	4231	2301	6006	6390	7634
Degree-days, Sept. 1 to Apr. 30, Normal	6396	2890	4511	2352	5800	6474	7344

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for April, 1936	663	641	488	626	545	437	520
Degree-days, Sept. 1, '35 to Apr. 30, '36.	7092	6738	5524	6228	5881	5562	7219
Degree-days, Sept. 1, '34 to Apr. 30, '35.	6207	5732	4487	5427	4873	4720	5851
Degree-days, Sept. 1 to Apr. 30, Normal	6893	6042	4684	5935	5236	5607	6266

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for April, 1936	678	346	950	88	681	396	605
Degree-days, Sept. 1, '35 to Apr. 30, '36.	6847	5207	9928	2335	6468	4910	6670
Degree-days, Sept. 1, '34 to Apr. 30, '35.	5653	4123	8745	2078	5792	3780	5671
Degree-days, Sept. 1 to Apr. 30, Normal	6264	4988	8721	2428	6009	4264	5804

	Grand Rapids, Mich.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Kansas City, Mo.	La Crosse, Wis.	Lincoln, Neb.
Degree-days for April, 1936	685	504	581	524	361	673	471
Degree-days, Sept. 1, '35 to Apr. 30, '36.	6878	5558	5865	6023	5596	8057	6743
Degree-days, Sept. 1, '34 to Apr. 30, '35.	6098	5102	5818	4883	4426	6906	5277
Degree-days, Sept. 1 to Apr. 30, Normal	6361	5285	5834	5239	4840	7139	5952

	Little Rock, Ark.	Los Angeles, Calif.	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.
Degree-days for April, 1936	223	140	412	709	253	726	753
Degree-days, Sept. 1, '35 to Apr. 30, '36.	3509	1112	4955	7885	3647	7289	8850
Degree-days, Sept. 1, '34 to Apr. 30, '35.	2660	1170	3898	6794	2691	6414	7303
Degree-days, Sept. 1 to Apr. 30, Normal	2811	1414	4180	7160	2950	6856	7614

	Nashville, Tenn.	New Haven, Conn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.	Omaha, Neb.
Degree-days for April, 1936	305	574	51	539	292	212	485
Degree-days, Sept. 1, '35 to Apr. 30, '36.	4092	5689	1401	5228	3616	3926	7161
Degree-days, Sept. 1, '34 to Apr. 30, '35.	3129	5536	948	5042	3206	2992	5407
Degree-days, Sept. 1 to Apr. 30, Normal	3578	5672	1024	5192	3349	3613	6047

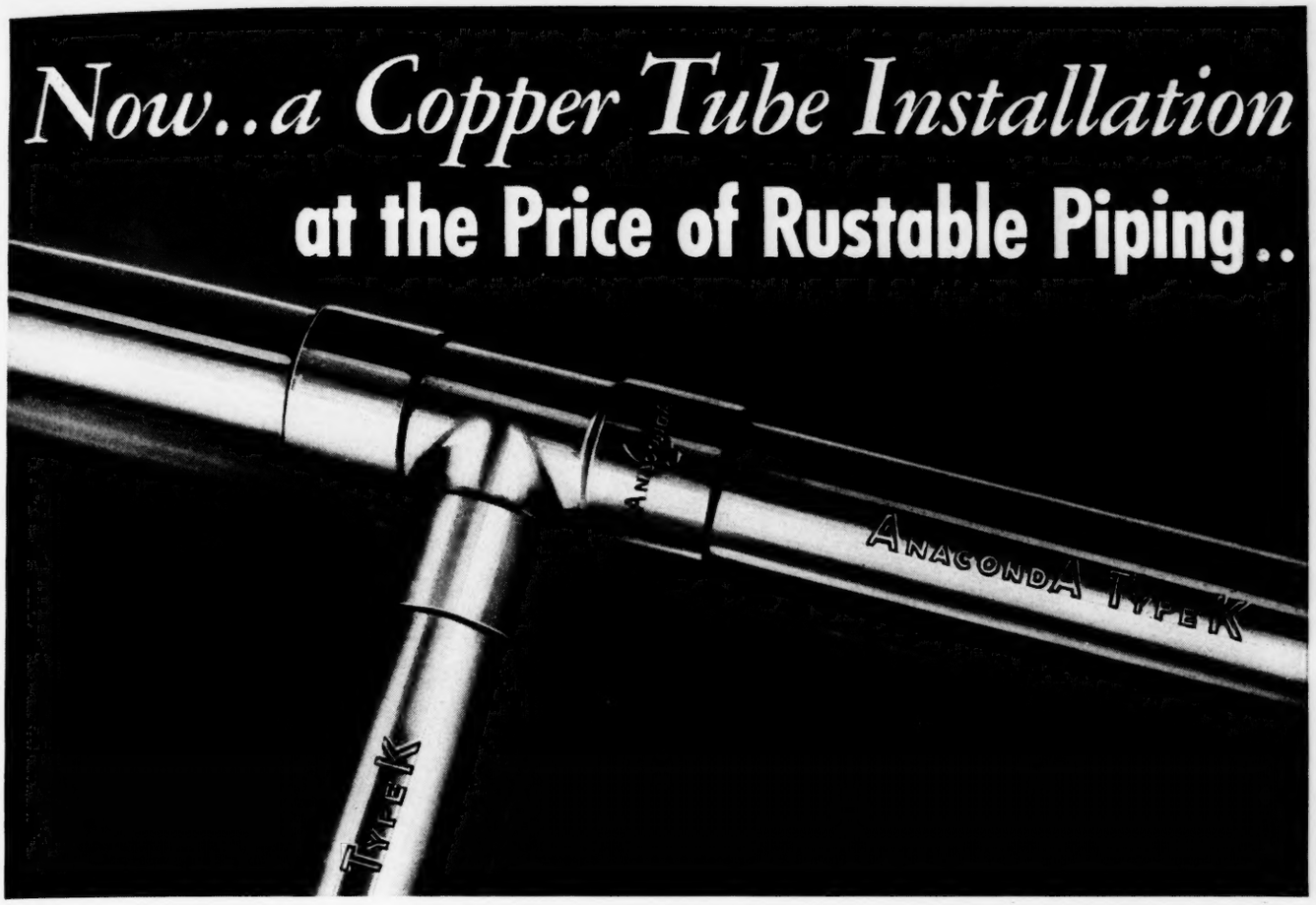
	Peoria, Ill.	Philadelphia, Pa.	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.
Degree-days for April, 1936	521	455	521	678	285	589	494
Degree-days, Sept. 1, '35 to Apr. 30, '36.	6640	4914	5600	6647	4229	5786	5391
Degree-days, Sept. 1, '34 to Apr. 30, '35.	5431	4564	4815	6839	3784	5757	5014
Degree-days, Sept. 1 to Apr. 30, Normal	5988	4787	5157	6644	4134	5763	5293

	Richmond, Va.	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco Calif.	Scranton, Pa.	Seattle, Wash.
Degree-days for April, 1936	353	698	411	327	190	578	335
Degree-days, Sept. 1, '35 to Apr. 30, '36.	4210	6705	5315	5306	2080	6181	4239
Degree-days, Sept. 1, '34 to Apr. 30, '35.	3821	6236	4127	4974	2104	5884	3967
Degree-days, Sept. 1 to Apr. 30, Normal	3725	6472	4585	5319	2418	5958	4397

	Spokane, Wash.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for April, 1936	394	656	635	497	609	404	316
Degree-days, Sept. 1, '35 to Apr. 30, '36.	6282	6630	6648	5376	6847	4685	5016
Degree-days, Sept. 1, '34 to Apr. 30, '35.	5610	6297	5775	5086	6609	4288	3983
Degree-days, Sept. 1 to Apr. 30, Normal	5989	6614	5893	4852	6543	4601	4673

To obtain unit fuel consumption figures for any city shown above, multiply the number of degree-days by the following factors: for coal, 0.008; for oil, 0.00069; for gas, 0.096. Figures obtained will show coal consumption in pounds per square foot of radiator surface; oil consumption in gallons per square foot; gas consumption in cubic feet per square foot—all for the period covered by the number of degree-days. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operation at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal; 140,000 B.t.u. per gal. for oil, and 1,000 B.t.u. per cu. ft. for gas. To correct for other heating values, efficiency and design conditions, follow the method explained in the "HEATING & VENTILATING Degree-day Handbook" or on H. & V.'s Reference Data Sheet Nos. 67 and 68. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

Now..a Copper Tube Installation
at the Price of Rustable Piping..



for plumbing, heating and air-conditioning lines

IN specifying for plumbing, heating and air-conditioning lines, the first cost of non-rust material can no longer be considered a drawback to its use. For the price of Anaconda Copper Tubes, assembled with Anaconda Solder-Type Fittings, is little or no more than that of pipe that rusts.

In addition to low cost, this sturdy tubing offers all the traditional advantages of copper—long life... trouble-free service... immunity to rust . . . freedom from periodic repair expense.

Copper tubes for heating lines

For heating lines... Anaconda Copper Tubes are ideal. Hot water conveyed through them loses only about *one-half* as much heat as is lost when black iron is used. Permanently smooth interiors reduce resistance to the flow. The result is quicker circulation and maximum efficiency.

A complete line of Anaconda Fittings

There is an Anaconda Fitting to meet *every* copper tube requirement. Solder-type fittings may be had in either wrought copper or cast bronze; flared-tube-type fittings are cast bronze. All are furnished in elbows, tees, couplings and unions, including a complete range of reduction and adapter combinations. Anaconda Copper Tubes and Fittings are carried in stock by distributors of Anaconda Pipe.

Where standard-size, rigid pipe is required, Anaconda Brass Pipe has long been the standard of quality. Two scientifically-determined alloys are carried in stock by leading supply houses... *Anaconda 67 Brass Pipe* for normally corrosive water, and *Anaconda 85 Red-Brass Pipe* for highly corrosive water.

3645

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

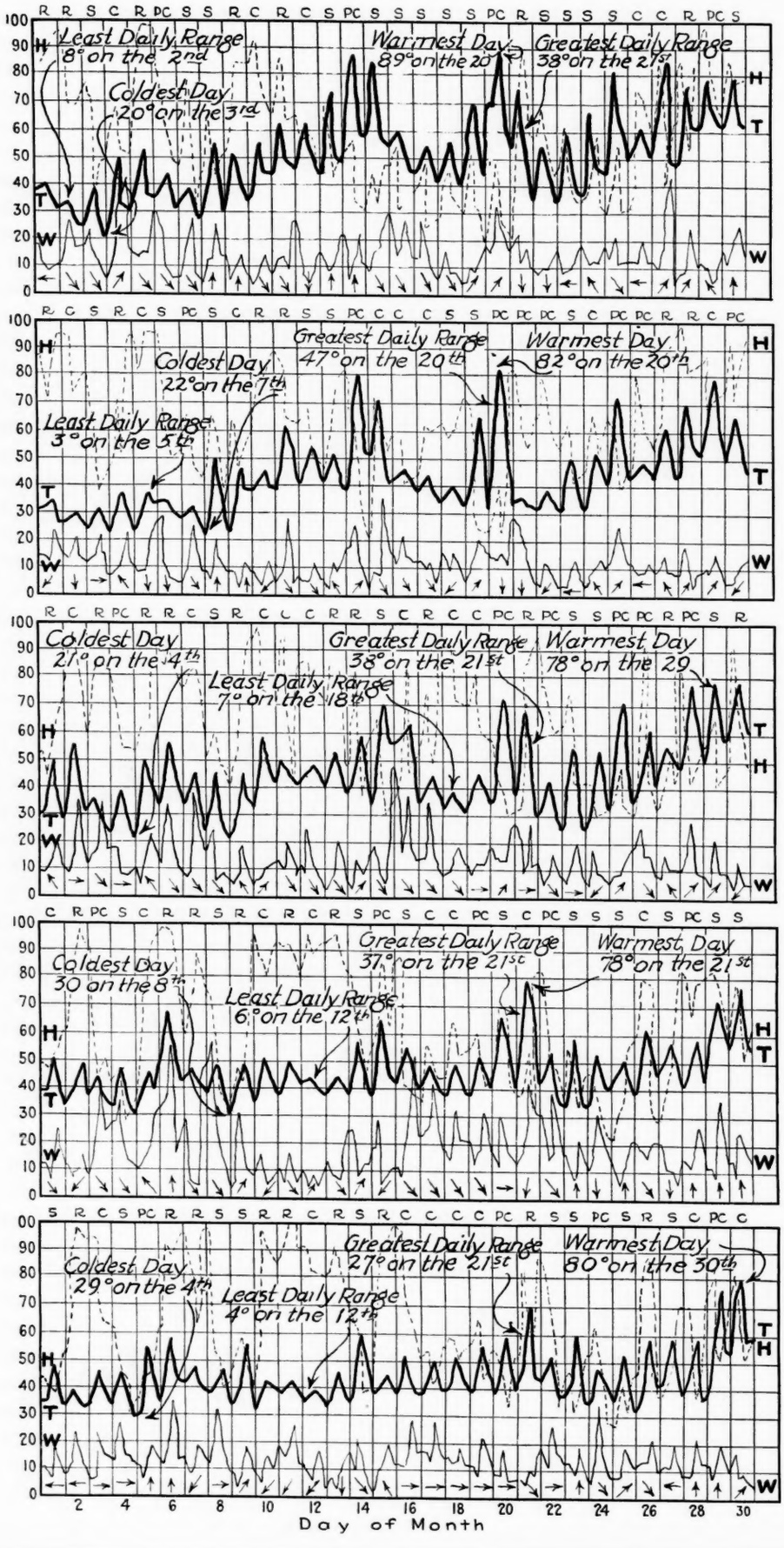
Offices and Agencies in Principal Cities

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont.

ANACONDA COPPER & BRASS

THE WEATHER FOR APRIL, 1936

Plotted from records compiled for HEATING & VENTILATING by the U.S. Weather Bureau. Heavy curves (T), dry bulb temperatures in deg. F.; dotted lines (H), per cent relative humidity from readings at 8 a.m., noon, and 8 p.m. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions, north being arrow pointing up, etc.; S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.


Least Daily Range 8° on the 2nd
Coldest Day 20° on the 3rd
Warmest Day 89° on the 20
Greatest Daily Range 38° on the 21st
Greatest Daily Range 47° on the 20th
Coldest Day 22° on the 7th
Warmest Day 82° on the 20th
Least Daily Range 3° on the 5th
Coldest Day 21° on the 4th
Greatest Daily Range 38° on the 21st
Warmest Day 78° on the 29
Least Daily Range 7° on the 18th
Coldest Day 30 on the 8th
Greatest Daily Range 37° on the 21st
Warmest Day 78° on the 21st
Least Daily Range 6° on the 12th
Coldest Day 29° on the 4th
Greatest Daily Range 27° on the 21st
Warmest Day 80° on the 30th
Least Daily Range 4° on the 12th
H
T
W
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

St. Louis

Mean temp. for month, 52.4 F; aver. wind velocity, 12.5 m.p.h.; prevailing direction of wind, NW.

Chicago

Mean temp. for month, 43.6 F; aver. wind velocity, 10.7 m.p.h.; prevailing direction of wind, NE.

Pittsburgh

Mean temp. for month, 45.4 F; aver. wind velocity, 12.1 m.p.h.; prevailing direction of wind, NW.

New York

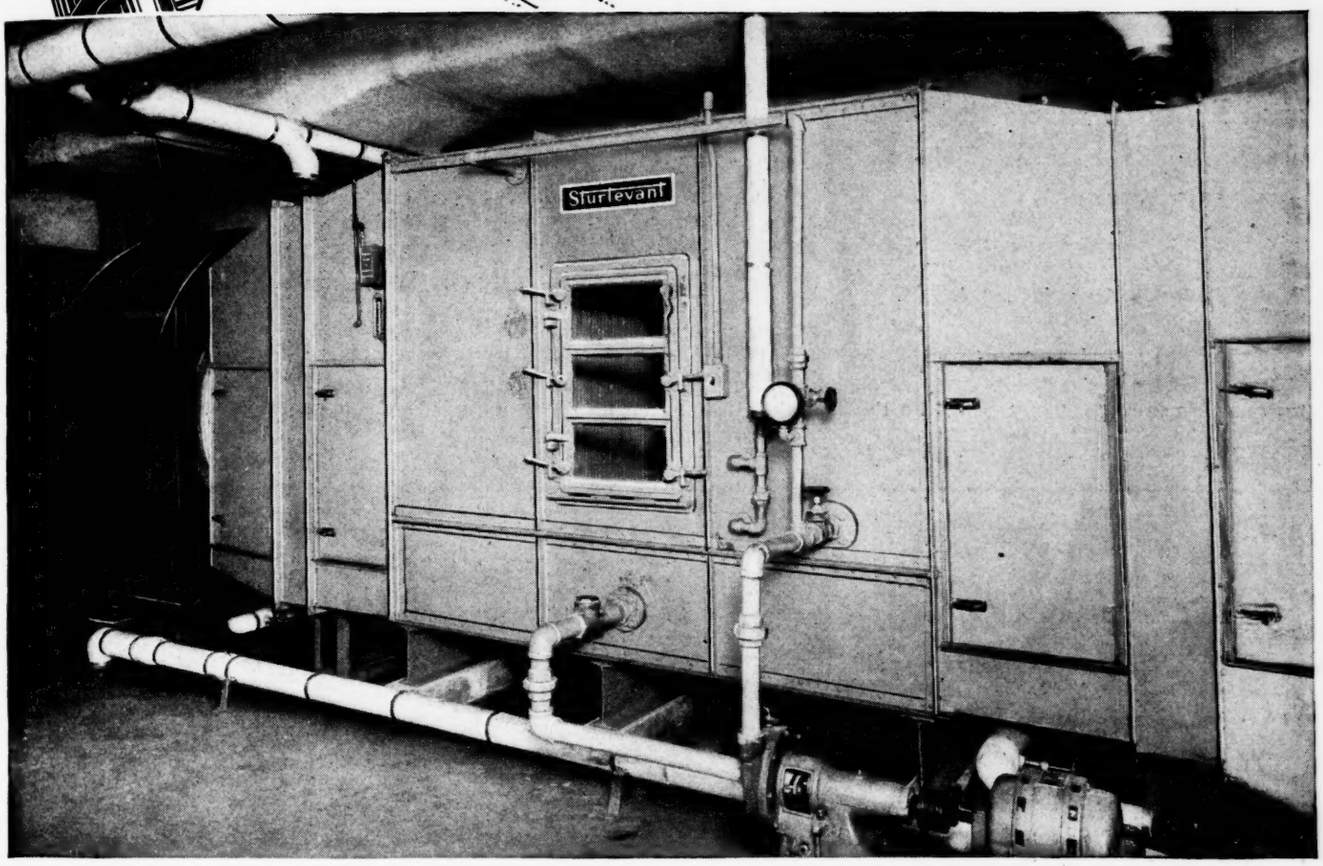
Mean temp. for month, 47.2 F; aver. wind velocity, 16.7 m.p.h.; prevailing direction of wind, NW.

Boston

Mean temp. for month, 45.2 F; aver. wind velocity, 12.3 m.p.h.; prevailing direction of wind, W.

AIR WASHERS

FOR EVERY NEED—LARGE OR SMALL



STURTEVANT has Air Washers in capacities for every need... in types for every public building, commercial or industrial use. ¶ Sturtevant makes available one *central source of supply* for air washers, fans, motors, control, heating and cooling coils. ¶ Take advantage of this convenience. It is time-saving... and it assures *undivided responsibility.*

B. F. STURTEVANT CO., Hyde Park, BOSTON, MASS.
New York, N.Y. 420 Lexington Ave. Chicago, Ill., 400 N. Michigan Ave.
San Francisco, Cal., 681 Market St. *Branch Offices in 40 Other Cities*

B. F. STURTEVANT COMPANY OF CANADA, LTD., GALT.
Sales Offices in Toronto and Montreal *Repres. in Principal Canadian Cities*

Photo shows Sturtevant Air Washer installed in new addition to building of Associated Screen News Limited, subsidiary of Canadian Pacific Railway Co. Capacity of unit...10,000 c.f.m. at 1" static.

Engineer: E. B. Plant (C. P. Ry. Engineering Staff). *Architects:* Staff of the C. P. Ry. *General Contractor:* A. Janin & Company, Limited. *Heating & Ventilating Contractor:* Webber & Grannery Sheet Metal Works.

Sturtevant
REG. U. S. PAT. OFF.

Puts Air to Work

SPECIALISTS IN AIR ENGINEERING FOR OVER 75 YEARS

WITH THE MANUFACTURERS

Airtemp, Inc., Detroit, Mich., has nearly finished installation of new machine equipment at its new Dayton, Ohio, plant where manufacture of all Airtemp products will soon begin.

The Airtherm Mfg. Co., 1474 S. Vandeventer, St. Louis, Mo., announces the election of the following officers: President, F. P. Kohlbry; vice-president, R. J. Tenkonohy; secretary, C. J. McEnery. The company is expanding its operations and lines of heating equipment, which include steam, hot water and direct fired unit heaters.

The American Rolling Mill Co., Middletown, Ohio, has appointed **Harry V. Mercer** as advertising manager. Mr. Mercer has been with the company since 1916.

Carrier Engineering Corp., Newark, N. J., has appointed **Walter A. Bowe** as manager of advertising and sales promotion, succeeding Brewster S. Beach, resigned. Mr. Bowe was formerly advertising manager for General Electric air conditioning.

Detroit Lubricator Co., 5842 Trumbull Ave., Detroit, Mich., has added **L. H. Schuette,** formerly assistant engineer gases and oils, Underwriters' Laboratories Co. organization, as an engineer in its oil burner control division.

Fairbanks, Morse & Co., Air Conditioning Div., Chicago, announces the appointment of the following distributors for Ortho-Clime equipment: **Hewitt-Reed Engineering Co.,** Cleveland; **Beckmeyer-Davis Co.,** Huntington, W. Va., and **Young & Bertke Co.,** Cincinnati.

Fitzgibbons Boiler Co., Inc., New York, has moved its general offices and showroom to **101 Park Ave.**

General Refractories Co., Philadelphia, Pa., announces the appointment of **E. Corey & Co.,** Portland, Me., as dealer agent in the Portland area. E. Corey & Co. will carry a complete stock of refractories.

Inland Steel Co., Chicago, has appointed **Joseph L. Block** executive vice-president in charge of sales, and **Albert C. Roeth** as vice-president and general manager of sales. Mr. Block has been associated with Inland since 1922. He has been a vice-president since 1929, and a director since 1930. Mr. Roeth has been associated with Inland since 1911, and has been a vice-president since 1929.

Iron Fireman Manufacturing Co., Portland, Oreg., has promoted **Karl E. Saboe** from the position of district representative to the newly-created position of industrial sales manager in the general sales department, Cleveland. Mr. Saboe has been with the company almost since its inception, during which time he has served in a number of departments, including installation and service, as well as sales.

Kelvinator Corp., Detroit, Mich., has appointed two new commercial air conditioning distributors and one mercantile distributor. At Ashland, Ohio, the **Smith Music Store** will handle standard commercial, liquid cooling, and automatic heating units. The **E. W. Heintz Co.,** Akron, will carry, in addition to the above lines, junior air conditioning units and room coolers. **Waterman-Waterbury Co.,** has been named mercantile distributor for complete air conditioning units exclusively at Minneapolis.

Kennedy Valve Mfg. Co., Elmira, N. Y., has appointed **R. M. Guiry** as manager of its Chicago branch office and warehouse. He has been connected with that office for the last nine years.

Minneapolis-Honeywell Regulator Co., Minneapolis, announces the following changes and additions: the **Detroit** branch office has moved from 2847 Grand River Ave. to larger quarters at **415 Brainard Ave.;** the **Providence** district office has moved from 803 Industrial Trust Building to **397 Elmwood Ave.;** in the territory served from the Atlanta branch office there are being established two new

(Concluded on page 72)

THERM-O-TILE

STEAM CONDUIT

6000 feet of THERM-O-TILE, for steam distribution, was used at the Federal Housing Project, Techwood, Atlanta, Ga. Covers 25 acres. Supplies steam to

700 FAMILIES

Ask for Bulletin 351 describing complete details of the THERM-O-TILE Conduit System.

DISTRIBUTORS

Alabama—Taylor-Seidenbach, Inc., Birmingham
Connecticut—Johns-Manville Sales Corp., Hartford.
Delaware—The Nicely Corp., Philadelphia.
District of Columbia—Reid Hayden, Inc., Washington.
Florida—The Brooks-Fisher Insulating Co., Atlanta.
Georgia—The Brooks-Fisher Insulating Co., Atlanta.
Illinois—Asbestos and Magnesia Materials Co., Chicago.
Indiana—General Asbestos & Supply Co., Indianapolis.
Kansas—Johns-Manville Sales Corp., Kansas City, Kan.
Kentucky—General Asbestos & Supply Co., Louisville.
Louisiana—Taylor-Seidenbach, Inc., New Orleans.
Maryland—Reid Hayden, Inc., Baltimore.
Massachusetts—Springfield: Johnson Asbestos Co.
South Boston: P. S. Thorsen Co.
Mississippi—Taylor-Seidenbach, Inc., New Orleans.
Missouri—Johns-Manville Sales Corp., St. Louis.
Nebraska—Johns-Manville Sales Corp., Omaha.
New York—New York City: Asbestos Construction Co., Inc.
Albany and White Plains: Johns-Manville Sales Corp.
Rochester and Syracuse: Smith-Murray Corp.
North Carolina—Reid Hayden, Inc., Charlotte.
Oklahoma—Johns-Manville Sales Corp., Tulsa.
Pennsylvania—The Nicely Corp., Philadelphia.
South Dakota—Johns-Manville Sales Corp., Omaha.
Texas—Houston: Aycock Corp., of Texas.
Dallas: Johns-Manville Sales Corp.
Virginia—Reid Hayden, Inc., Richmond.
Wisconsin—Milwaukee Insulation Co., Milwaukee.
Canada—Montreal and Toronto: Canadian Johns-Manville Co., Ltd.

H. W. PORTER & CO., INC.
825 Frelinghuysen Ave., Newark, N. J.

INSTANT POWER

with the MODUTROL SYSTEM

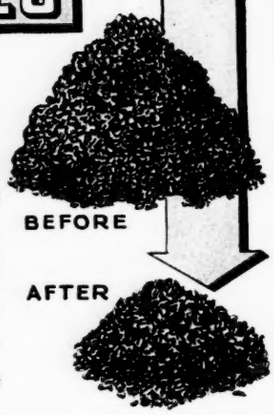
Since the Minneapolis-Honeywell Modutrol System of heating, ventilating and air conditioning control is electrically operated, it provides instant power to valves, dampers and louvers. It consequently provides greater control accuracy than is possible with systems having inherent lag between the time thermostats call for change and the time such changes in control actually occur. Minneapolis-Honeywell Controls are backed by a half century of research and practical field experience. When you specify control equipment, select the best. It always pays. Minneapolis-Honeywell Regulator Company, 2715 Fourth Avenue South, Minneapolis, Minn. Branches everywhere.

MINNEAPOLIS-HONEYWELL

Control Systems

BROWN INSTRUMENTS FOR INDICATING, RECORDING AND CONTROLLING

Coal Bills Go Down When SARCO Goes In!



Keep condensate out of radiators and you will greatly increase the heating efficiency of all the fuel consumed.

Sarco Radiator Traps automatically expel condensation without the loss of any of the heating medium.

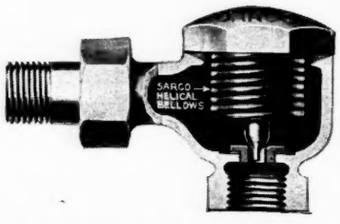
They prevent noisy, air-bound, water-hammering radiators and insure maximum heating all the time.

SARCO RADIATOR TRAPS

are quality traps through and through. The body is in non-corrosive cast bronze, nickel finished with polished trimmings.

Bellows is made of heavy seamless helically corrugated tubing. Valve heads are self-aligning. Traps are noiseless and economical in operation.

Write for our interesting catalog P-45.



SARCO COMPANY, INC.

183 Madison Ave., New York, N. Y.

Branches in Principal Cities

Sarco Canada Limited, Federal Bldg., Toronto, Ont., Canada

(Concluded from page 70)

district offices, one in New Orleans, La., where **Paul E. Seepe** will be in charge, and the other at Charlotte, N. C., where **Karl Selden** will be in charge. Street addresses for these two new offices are not yet available; the European branch office, formerly at 233 Heerengracht, Amsterdam, Holland, has moved to new and larger quarters at **Wydesteeg-4** in the same city.

Minneapolis-Honeywell Regulator Co., Minneapolis, has enlarged its plant and main office, providing nearly 50% more floor space than has been available in the plant. The new space is in a wing on top of which has been built an experimental bungalow, an insulated frame structure in which provision has been made for heating by warm air or radiator heating and equipped with ductwork for air conditioning. Beneath the house is a test department of the engineering division in which are located the boiler, furnace, and air conditioning equipment by which any desired method of conditioning or heating may be applied to the experimental bungalow.

As a further addition to the company's research facilities, as well as for the comfort and efficiency of office employes, three complete air conditioning installations have been made to provide air conditioning for the offices and engineering department on the entire sixth floor, and a portion of the fifth floor. Cooling apparatus in these installations has capacity the equivalent of 248½ tons of refrigeration. This installation will give an opportunity for first-hand study of various means of operating air conditioning equipment and various control applications, as well as the improvement in efficiency and comfort of employes.

National Radiator Corp., Johnstown, Pa., has appointed **A. A. Ahlff** as manager of its Philadelphia branch sales office. He assumed the duties of his new position May 1. For some time prior to joining the National Radiator Corp. organization, Mr. Ahlff was associated with Chase Brass & Copper Co., Waterbury, Conn., and had most recently served as manager of that company's heating products division. He has had a wide experience in the heating business, having been connected with the Cedar Rapids Pump Co., U. S. Radiator Corp., and Spencer Heater Co.

Republic Steel Corp., Cleveland, Ohio, announces that **Julius Kahn,** who has been president since his founding of Truscon Steel Corp., has resigned his position to become vice-president in charge of product development of Republic. **Forrest H. Ramage** has been promoted from assistant manager of the advertising and sales promotion division to sales promotion manager and will work in conjunction with the new product development division. **Stanley A. Knisely,** formerly manager of the advertising and sales promotion division, has been named director of advertising with direct supervision of all advertising of the corporation and its subsidiaries. **Chester W. Ruth** has been made assistant director of advertising.

Republic Steel Corp., Cleveland, Ohio, has appointed **L. L. Caskey** district sales manager in the Philadelphia territory, according to N. J. Clarke, vice-president in charge of sales. **J. B. DeWolfe,** whom Mr. Caskey succeeds, has been transferred to the general offices in Cleveland to assist George E. Totten, manager of sales of the tin plate division. Republic also announces that it has appointed **Noland Co., Inc.,** Washington, D. C., Toncan Iron sheet distributor in that territory. Republic's New York district sales office has opened a new sub-office in the State Bank Building, Albany, N. Y., with **J. M. Higinbotham** salesman in charge.

Young Radiator Co., Racine, Wis., has added **Warren Ewald** to its staff. Mr. Ewald has long been connected in manufacturing, research, and development in the heating, ventilating, and air conditioning products field.

Young Ventilating Co., 4500 Euclid Ave., Cleveland, manufacturer of regulating dampers for use in ducts, announces that its company name has been changed to **Young Regulator Company.**

ABSTRACTS

Oil Heating Handbook

In presenting this handbook of oil heating, it is the author's purpose to make available in a convenient form the large mass of data and information needed by the workers in this field. The author is to be congratulated on the excellent job that he has done in gathering and arranging this information.

The book is divided into seven main sections and these main sections are further divided into 19 sub-sections. After a brief introduction in which the various types of oil burners are described and classified, the book discusses the properties of heating oils, flames and combustion.

The next section deals primarily with the heating system —what types are available, their advantages and disadvantages, and the selection of the proper type and size. A rather complete listing is made of the various types of steam and hot water systems. The selection of the proper type of controls is also taken up in this section.

The actual method of making a survey of the heating system for the selection of the proper size and type of oil burner is outlined in the fourth part. This part also discusses the installation and servicing of the oil burning equipment and a number of valuable pointers are given.

A rather good explanation of the properties of sound and the methods of eliminating it is given in the fifth part. This section should be of considerable interest since the subject has never received the attention that it deserves and there is a scarcity of available information.

A discussion of retail selling both from the standpoint of the manager of sales and of the sales is given in the sixth part. Among the subjects taken up are the selection of salesmen, territory surveying, supervision of sales, and the training of salesmen. The seventh part is made up of a list of explanations of technical terms, tables and statistics, weather charts, etc.

[*"Oil Burning Handbook" by Han A. Kunitz and published by J. B. Lippincott Co., Philadelphia, Pa. Flexible binding; 5 x 8 in.; 456 pages; price, $3.50.*]

COMING EVENTS

JUNE 9-11, 1936. SHORT COURSE IN COAL UTILIZATION, DEPARTMENT OF MINING AND METALLURGICAL ENGINEERING, *University of Illinois, Urbana, Ill.*

JUNE 11-13, 1936. ANNUAL MEETING OF STOKER MANUFACTURERS' ASSOCIATION, GREENBRIER INN, *White Sulphur Springs, W. Va.*

JUNE 16-19, 1936. NATIONAL DISTRICT HEATING ASSOCIATION CONVENTION AND EXHIBIT, *Pantlind Hotel, Grand Rapids, Mich.*

JUNE 17-18, 1936. NATIONAL WARM AIR HEATING AND AIR CONDITIONING ASSOCIATION CONVENTION, *Deshler-Wallick Hotel, Columbus, Ohio.*

JUNE 17-20, 1936. SEMI-ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, *Hotel Adolphus, Dallas, Tex.*

JUNE 22-24, 1936. SEMI-ANNUAL MEETING AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS AND AMERICAN SOCIETY OF REFRIGERATING ENGINEERS (JOINT MEETING), *Buck Hill Falls, Pa. (ASRE headquarters at Skytop, Pa.)*

OCTOBER 26-30, 1936. EIGHTEENTH ANNUAL CONVENTION OF AMERICAN GAS ASSOCIATION, *Atlantic City, N. J.*

NOVEMBER 30-DECEMBER 4, 1936. FIFTY-THIRD ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, *Engineering Societies Bldg., New York.*

NOVEMBER 30-DECEMBER 5, 1936. 12TH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING, *Grand Central Palace, New York.*

• of Drinking Water Systems

Where brine is used as the refrigerant in drinking water cooling, or in other refrigerating and air conditioning services—Sylphon Z-Type Regulators are the preferred controls.

Simple, self-contained, self-powered—they are inexpensive, easily installed, require no auxiliary equipment or power for operation.

Accurate—they hold temperatures "on-the-line," day in and day out.

Dependable—they may be installed and forgotten.

Recent outstanding improvement in Sylphon controls for low temperature service—a "freeze-proof" valve that will not frost up, become sluggish or freeze when subjected to temperatures as low as 70° F below zero.

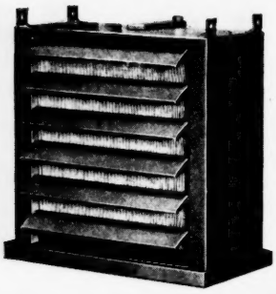
These and other modern Sylphon controls of vital interest to the architect and engineer are described in the following recently issued bulletins.

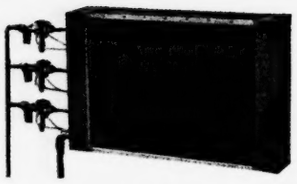
•

Individual Room Temperature Control—Bulletins LH 80 and LH 70 . . . Zone Control—Bulletin LH 70 . . . Space Heat Control in Large Industrial Areas—Bulletins LH 50 and LH 70 . . . Duct Type Heating and Air Conditioning Controls—Bulletin LH 50 . . . Service Hot Water Supply Control—Bulletins LH 20 and LH 40 . . . Drinking Water Temperature Control—Bulletin LH 20.

FULTON SYLPHON CO.
KNOXVILLE, TENN., U.S.A.

Sales Representatives in Principal Cities





EVAPORATORS

UNIT COOLERS
COMMERCIAL UNITS
BLAST UNITS

YOUNG COOLING EQUIPMENT

FOR AIR CONDITIONING COMFORT COOLING & COMMERCIAL APPLICATIONS

The Young line of cooling equipment is complete and well graduated in capacities. Thus the architect, heating contractor or engineer may select Young products to meet his most exacting specifications.

EVAPORATORS for use with methyl chloride are available in capacities up to 30 tons of refrigeration; for Freon up to 20 tons of refrigeration.

UNIT COOLERS for use with water, brine, or any common refrigerant. 3 models varying in capacities from 1/3 to 2 tons of refrigeration.

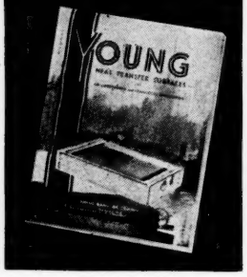
COMMERCIAL UNITS which are compact in design to operate in conjunction with air conditioning equipment or machines where heating or cooling surfaces are required.

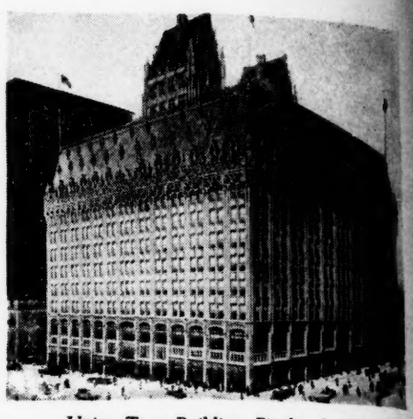
BLAST UNITS in many sizes and capacities for installation in blast heating or cooling system.

YOUNG RADIATOR Company
RACINE, WIS.
Young Quality

YOUNG RADIATOR CO.,
Racine, Wis.
- ☐ Send Heating-Cooling Catalog 435.
- ☐ Send Air Conditioning Folder 236.
- ☐ Send Evaporator Catalog 535.
- ☐ Send Unit Cooler Catalog 434.
- ☐ Send Unit Heater Catalog 534.

Name.....
Company.....
Address.....





Union Trust Building, Pittsburgh, Pa.

UNION TRUST BUILDING CUTS HEATING EXPENSE

Webster Heating Modernization Program Pays For Itself In Less Than Three Years

Pittsburgh, Pa. — When the management of the Union Trust Building entered into a contract for a Webster Heating Modernization Program in August, 1932, Webster engineers conservatively estimated that the modernized system would save $3,160 a year. The installation contained a total of 54,000 square feet of direct radiation.

In less than three years, the savings have been sufficient to more than repay the entire investment of $9,000 as well as interest at six per cent. per annum on the investment. The following are the actual measured yearly savings:

1933	$4,265.54
1934	4,323.83
*1935	3,752.79

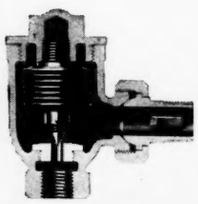
* Up to Dec. 1, 1935, this date marking the termination of period for recovery of initial investment, with interest.

This sharp reduction in heating expense followed conversion of a modern vacuum heating installation into a Webster Moderator System. Orifices were installed in branch mains and in all radiators to balance steam distribution.

Automatic "Control-by-the-Weather" was applied through an Outdoor Thermostat actuating a central throttling control valve. A manual Variator permits the operator to increase steam delivery for heating up, reduce steam supply in evening hours and make any adjustments for unusual weather conditions.

Installation of this equipment was made by McGinness, Smith & McGinness, Pittsburgh Modernization Heating Contractors. Webster engineers cooperated with the management of the Union Trust Building in working out proper operating schedules to assure maximum savings consistent with heating comfort.

By holding temperatures to the desired level of approximately 72 degrees indoors, the Webster Moderator System has checked window opening and increased tenant comfort. Since November, 1935, when the investment was completely liquidated, the Union Trust Building has continued to enjoy superior heating service at a permanently lowered cost.



The World Famous Webster Sylphon Trap

Traps of this type are standard equipment on all radiators in the Union Trust Building.

The entire statement of performance of the Union Trust Building installation, as given here, has been submitted and approved as correct by Solomon C. Whipkey, Manager of the Union Trust Building.

If you are interested in heating *new* buildings, or in improved heating service and lower heating cost in your present building, address

Warren Webster & Company . . . Camden, N. J.
Pioneers of the Vacuum System of Steam Heating
Branches in 60 principal U. S. Cities . . . Darling Bros., Ltd., Montreal, Canada